CHILD MORTALITY AND GROWTH ATTAINMENT IN BURUNDI, UGANDA AND ZIMBABWE

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I hereby declare that this thesis is entirely my own original work, carried out at the National Centre for Epidemiology and Population Health at The Australian National University.

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ABSTRACT

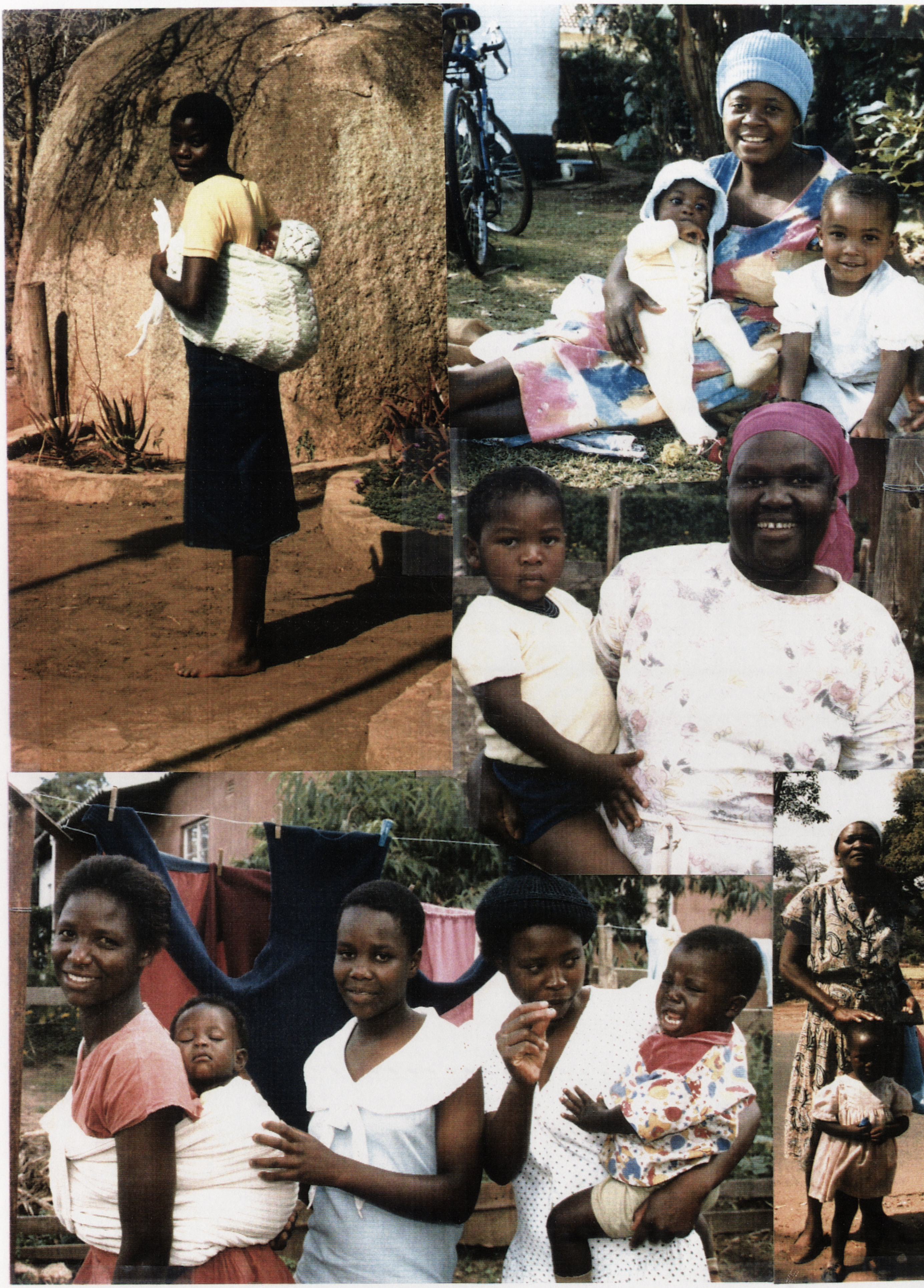
There is a well developed theoretical framework for the study of the association of socio-economic, demographic, environmental and child-care factors with child mortality, which recognises the role of malnutrition and growth faltering. However, less attention has been given to the study of poor growth attainment among the 80 or 90 per cent of children who survive. Although it is widely recognised that moderately poor growth attainment is not itself a good predictor of mortality, little is known about why some poorly grown children have a greater risk of mortality than others.

This study addresses this gap in knowledge by proposing and testing a framework for the study of poor growth attainment, and by comparing the correlates of mortality and poor growth attainment among children in Burundi, Uganda and Zimbabwe. It utilises cross-sectional data sets which include a wide range of socio-economic, demographic, environmental and child-care factors, as well as anthropometric measurements for children up to age five years.

The analysis shows that, although at birth children in the three countries are close to the international reference standards for child growth, there is a marked and sustained deterioration in mean growth attainment during the first two years of life. By the end of their second year substantial proportions of children in each country are stunted and/or underweight, as a consequence of poor nutrition, infection, and socio-economic and environmental factors; but the majority of these children survive.

The analysis of patterns of mortality and patterns of poor growth attainment shows that, while the correlates of mortality are predominantly demographic, the correlates of poor growth attainment are predominantly environmental. However, short birth intervals are strongly associated with both mortality and poor growth attainment. An examination of clustering of mortality and poor growth attainment within families provides further evidence that there is a greater risk of child mortality in families in which both poor growth attainment and short birth intervals are present.

These findings suggest that demographic factors, particularly birth interval, as well as growth attainment, should be taken into consideration when children are selected for special health interventions. It also points to the need for further research on the factors which increase the risk of mortality of some children with poor growth attainment.



Women and Children of Zimbabwe

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CHAPTER ONE: INTRODUCTION

1.1 THE RESEARCH PROBLEM

This purpose of this study is to examine and compare patterns of child mortality and growth attainment in Burundi, Uganda and Zimbabwe. The African continent is the world's most disadvantaged region in terms of child survival and nutrition. Under-five mortality rates of 200 per thousand or more were reported for 17 developing countries in 1991, with a further 47 exceeding 70 per thousand (UNICEF, 1993: 68). Twenty-eight of the 35 countries classified as having 'very high under-five mortality' in 1991 were in Africa (UNICEF, 1993: 68). No African country was rated as having less than 'high under-five mortality' in 1991, and sub-Saharan Africa was the region with both highest infant mortality and highest under-five mortality (UNICEF, 1993: 69).

High infant and child mortality wastes human energy and resources, as well as depriving individuals of the opportunity to enjoy a rich and fulfilling life and to make a contribution to society. In Africa it further depletes the resources of many countries which are already resource poor. The energy that goes into bearing and nurturing a child is wasted if that child dies. Women must spend more time pregnant and caring for children in order to achieve their desired family size, and so are less able to contribute to family income. There are also the emotional costs of child loss, which can severely stress parents and impair their health and productivity, as well as their happiness.

There is convincing evidence that high infant and child mortality supports high fertility (see, for example, Heer and Smith, 1968; CICRED, 1975; Muhsam, 1977). Parents who regard the loss of some of their children as inevitable tend to be disinterested in advice to plan and space their families (Orubuloye, 1977: 391; Royston and Armstrong, 1989: 54). Juarez (1993: 56) pointed out that the association of fertility decline and child survival has been recognised since the mid-nineteenth century. She classified the association as various 'effects' of child survival or death on fertility: 'the physiological effect' of prolonged lactation on ovulation; 'the replacement effect' when parents continue to produce children to replace dead offspring; 'the insurance effect' when parents produce the number of surviving children they consider necessary to protect their own future; 'the transitional effect' when child survival increases and parents gain the ability to predict and plan their family size; and 'the extrafamilial effect' including societal customs which ensure that community fertility is in balance with community mortality levels.

Improving child survival is thus a pre-requisite for the reduction of fertility to sustainable levels. Brass (1993) demonstrated the close association between declines in child mortality and declines in fertility in Kenya. He suggested that, although detailed data are lacking, the same association exists elsewhere in sub-Saharan Africa.

Hill (1992) analysed a selection of data sets for a wide range of African countries, and found considerable variations in levels and differentials in infant and child mortality, both between regions and between countries within regions. West Africa was generally the most disadvantaged (Hill, 1992: 24). Although there was evidence of a decline in the probability of dying before the age of five years in most African countries, in much of the continent, mortality for ages 1-4 years was as high as, or higher than, mortality in the first year of life (Hill, 1992: 12).

This is in stark contrast to the expected pattern, that children's risk of death is highest in infancy and declines in childhood[1]. As discussed in detail in Chapter Two of the present study, infant mortality is affected by biological and maternal factors, which tend not to affect child mortality. Hence, higher levels of child mortality are usually produced by very disadvantaged socio-economic and environmental conditions.

As in much of the developing world, the ultimate cause of the majority of infant and child deaths in Africa is infection, with malnutrition an important underlying cause. Poverty manifests as poor sanitation, poor access to health services and food shortages. These conditions have greatest impact on the most vulnerable groups, particularly infants and weanlings who have not had time to develop a partial immunity to contaminated food and water.

Although many infant and child deaths go unreported or without accurate diagnosis of their cause, UNICEF (1993: 6) estimates that there are almost 13 million infant and child deaths in developing countries each year. Of these some 60 per cent are caused

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1 The present study is concerned only with mortality of children up to age five. The term 'infant mortality' will therefore be used to refer to mortality of children aged 0-11 months, and 'child mortality' to mortality of children aged 12-60 months. The latter category was selected to accommodate the entire age range for which growth attainment and health care data were available for this study.

by pneumonia, diarrhoeal diseases or vaccine-preventable diseases, either singly or in combination. Vaccine-preventable diseases alone account for just over 2 million deaths, of which measles accounts for almost a million and neonatal tetanus more than half a million, while pertussis and tuberculosis make up most of the balance.

The expansion of primary health care during the 1980s, particularly the Expanded Programme of Immunization (EPI), has had a substantial impact on infant and child mortality. Most under-five mortality rates of 70 or more reported in UNICEF (1993) are at least one-third less than those for 1960. Yet there is still much scope for improvement. Of the total estimated deaths each year, 63 per cent are described by UNICEF as 'preventable at low cost'. This includes improving immunization coverage and use of simple treatments such as oral rehydration therapy (ORT) for diarrhoeal diseases.

The impact of various health care strategies varies between communities. Barnum and Barlow (1984: 368), who proposed different intervention priorities for rich and poor communities, suggest that organizations wishing to maximize the cost-effectiveness of their health investment should target poor communities. Abrahams (1988) recommended a 'high risk' approach to targeting investment to reduce maternal and perinatal mortality. In some circumstances changes in feeding practices and hygiene may bring greater overall benefits to health than increased utilization of medical services, while in others utilization of medical services has the greatest impact.

The debilitating effect of malnutrition causes higher mortality from preventable diseases in Africa and other developing regions than in developed countries. Many studies have demonstrated the importance of the link between malnutrition and infection (for example, Chowdhury and Chen, 1977; Kielmann and Associates, 1983; Kusin and Jansen, 1984; Martorell and Ho, 1984; and numerous others reviewed in Tomkins and Watson, 1989). Malnourished children have greater susceptibility to infection and less ability to recover than do well nourished children. Gwatkin, Wilcox and Wray (1980) reviewed ten intervention projects which provided food supplementation and/or medical services and found that, even when only food supplementation was given, reductions in infant and child mortality were substantial. Although there was not necessarily a reduction in the prevalence of infection, children were better nourished and more able to withstand episodes of illness. Kielmann, Ajello and Kielmann (1982) reached a similar conclusion after reviewing six projects which emphasized vitamin supplementation.

As well as being a major cause of mortality, infection and malnutrition also affect the health of the 80 to 90 per cent of children who survive. Growth faltering (slowing or cessation of growth) and stunting (low height-for-age), impaired physical performance, metabolic disorders, apathy and lethargy are just a few of their manifestations. The 'malnutrition-infection' complex is thus considered by many to be the most prevalent public health problem in the contemporary world (Tomkins and Watson, 1989: 1).

The Food and Agriculture Organization (FAO, 1987a: 19-22) used estimated caloric intake to measure the incidence of undernutrition in 98 developing countries. Data derived from national food balance sheets were compared with the estimated requirements for 1.2 and 1.4 times the basal metabolic rate (BMR) for people of a given size. According to the different requirements estimated for each country, the percentage classified as undernourished in Africa in 1979-1981 was 19 per cent for 1.2 BMR, and 26 per cent for 1.4 BMR. This was more than double the percentage in the Near East and more than either the Far East or Latin America. Although this was a small decline from 20 per cent 1969-1971 and 29 per cent in 1979-1981, the decline was less in Africa than in other regions.

Food and Agriculture Organization and World Health Organization (FAO/WHO, 1992: 4) reported a particularly serious situation in sub-Saharan Africa as a result of prolonged droughts and declining food production. On the basis of the different cut-off point of 2600 kcal per capita Dietary Energy Supply (DES), which is roughly equivalent to 1.54 BMR (FAO/WHO, 1992: 6), Africa still showed a small decline in chronic undernutrition, from 35 per cent in 1969-71 to 33 per cent in 1988-90 (FAO/WHO: 1992: 7). Again, this was substantially less than the decline in other developing regions.

Malnutrition may take the form of an absolute deficiency of food as measured by calories, or it may be a deficiency of certain dietary components. For example, kwashiorkor is caused by a deficiency in proteins. It may occur where plenty of food is available and children have sufficient gross caloric intake. It is thus related to dietary composition rather than quantity, and commonly occurs when newly weaned children are fed exclusively on carbohydrates (Werner, 1979: 113) In contrast, marasmus is caused by an absolute deficiency in total intake of food of all kinds, including protein. It is more likely to occur at times of severe food shortage, such as during famines or among children in situations of extreme poverty.

Deficiencies of micro-nutrients also can produce physical impairment. Iodine deficiency disorders range from goitre to cretinism and dwarfism; vitamin A deficiency can lead to blindness and lowered resistance to infections; and iron deficiencies lead to chronic anaemia. African populations experience deficiencies of micro-nutrients, including iodine, vitamin A, iron, vitamin B1, niacin, vitamin C, vitamin D, fluoride, zinc and selenium (FAO/WHO, 1992: 15-16), although rates are not always higher than in other regions.

Malnutrition may affect children even before they are born. Iodine deficiency increases the rate of stillbirths, spontaneous abortions and infant mortality, and can produce congenital abnormalities and cretinism in the foetus (Hetzel, 1989: 85). The World Health Organization (WHO, 1992a: 9) reported that in Africa as a whole, half of all pregnant women and more than 40 per cent of non-pregnant women are anaemic. The prevalence is highest in West Africa, and apparently lowest among those women in South Africa who use iron cooking pots. Although overall levels are slightly less than those of Asia, anaemia is nonetheless a significant health problem for African women, and contributes to maternal mortality rates of up to 1000 per 100,000 live births in some parts of the continent (Royston and Armstrong, 1989: 31, 87). Maternal loss usually signifies reduced care and nutrition for any surviving children, while children whose anaemic mothers survive are likely to be of low birthweight and to have poor growth attainment because of maternal depletion.

Yet, although most forms of malnutrition are easily recognised in children, in all but the most extreme cases it is difficult to say with any certainty which of a group of malnourished children will survive and which children will die. Nor can it be stated absolutely what level of malnutrition will result in permanent growth impairment, or even what level of growth impairment will prevent an individual from leading a healthy and productive life. Although the aetiology of childhood diseases and the association of malnutrition and infection are well known, the relationship can be expressed only in general terms. Despite abundant research, the link between malnutrition and mortality or malnutrition and infection has not been quantified.

Both well-nourished and malnourished children can contract infections and die from them. The survival of a sick child depends on a host of factors related to the type of infection and its severity, the way it acts upon the body and the treatment given to the child. A confounding factor is that infection often has a synergistic relationship with malnutrition. That is, infection impairs nutritional uptake and thus exacerbates malnutrition, while the malnourished state lowers resistance to infection and thus increases its severity. The combined effect of malnutrition and infection is thus greater than the sum of their separate effects.

Another reason for the lack of precise knowledge of the impact of malnutrition is the complexity of measuring it. As well as measurements of height, weight and other dimensions, a battery of tests is required to measure the exact nutritional status of an individual and to identify micro-nutrient deficiencies. This includes laboratory tests of blood and other body components, as well as body measurement. Such detailed assessment is seldom carried out, even in the developed world. As a consequence, medical personnel tend to infer malnutrition from observation and from body measurements. However, body measurements are actually measures of growth attainment at a given age and point in time, rather than definitive measures of malnutrition.

Moreover, in addition to laboratory testing of nutritional status, a comprehensive long-term study of malnourished children which sought to quantify the links between malnutrition and infection would need to monitor food intake. Because of practical difficulties this has rarely been attempted for more than a short period. There are also ethical problems associated with expenditure to monitor malnourished children rather than to feed them.

These methodological obstacles have had substantial repercussions in limiting assessment of the impact of food intervention programmes. The objective of most nutrition intervention programmes is to prevent deaths and reduce malnutrition (Jennings et al., 1991: 4-8). However, even in situations of severe food shortage, when food supplementation programmes become mandatory, they are inevitably undertaken without precise knowledge of their potential impact. For example, in Zimbabwe in 1992 it was not known how much food children were receiving from family sources or whether the daily ration provided by the programme to children in drought affected areas was sufficient to prevent growth retardation (J. Tagwireyi, personal communication).

Most countries face financial and organizational constraints which make it virtually impossible to address all child health problems simultaneously. The need to be cost-effective, to maximise benefits in terms of health improvements, and to achieve measurable results, inevitably prioritises projects which focus on areas where substantial reductions in child morbidity or mortality can be demonstrated. The promotion of breastfeeding in Papua New Guinea in the late 1970s (Biddulph, 1981) and the elimination of neonatal tetanus in Deschappels, Haiti, during the period 1940-1972 (Foster, 1984: 125) are two of many examples that might be cited. Juarez (1991) and Loyola (1993) noted the strong association of specific health programmes, especially the provision of maternal child health (MCH) centres, with reductions in infant and child mortality in Ecuador and Brazil. Mburu and Boerma (1991) pointed out that the health development policies of countries such as Zimbabwe, Kenya and Uganda favour the expansion of health services, especially MCH.

Broad brush programmes such as UNICEF's GOBI-FFF[1], described in Cash, Keusch and Lamstein (1987), rely on the support of international agencies, as they tend to be expensive while their effectiveness is not easily measurable. Investments in the provision of additional facilities and services, which are highly visible and which yield measurable health improvements, are inevitably more attractive to governments than expenditure on food supplementation programmes. Often food programmes may appear as no more than stop-gap measures which are difficult to evaluate.

LeSar et al. (1987: 197) and Qualls and Robertson (1989: 59) observed that immunization programmes are one of the health interventions most suited to cost-effective analysis. They are readily measurable in terms of doses and expenditure and numbers of expected disease cases and deaths averted, although Diamond et al. (1991) pointed out that measurement of their likely impact on a population is more complex. In contrast, while the efficacy of nutrition interventions is well documented, scientific rigour has been lacking in their assessment.

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1 GOBI-FFF stands for growth monitoring, oral rehydration therapy, breastfeeding, immunization, female education, family spacing and food supplementation.

> *This has often led to uncertainty in priority selection and resource allocation for nutrition and to diffidence in the design and implementation of intervention programmes. Policy makers and programme managers alike have been unable to present convincing arguments for the relative need, effectiveness and cost of nutrition interventions in relation to competing health activities such as immunization, rehydration therapy or family planning. As a consequence the priority assigned to nutrition is often low despite evidence of need for investment in this area from surveys, monitoring and service records.* (Jennings et al., 1991: 1).

It is small wonder that in the absence of precise information on the impact of malnutrition on health, governments tend to be reluctant to launch into large-scale programmes to improve nutrition. Beaton and Ghassemi (1982) concluded from their review of food programmes that they tend to be expensive for the measured benefit while anthropometric improvement was surprisingly small. However, they attributed much of this to limitations in program design and organization, and commented that few projects were able to provide information on whether the food actually reached the target population (Beaton and Ghassemi, 1982: 867). Esquivel Rios (1981: 232) commented that the results of a food supplementation programme in Bahia, Brazil, were 'quite disappointing because the proportion who improve is small' and the condition of some children receiving supplements deteriorated. Nonetheless, her study also showed that 57 per cent of those who were initially wasted (low weight-for-height), but not stunted, and 33 per cent of those who were stunted but not wasted became normal after supplementation for periods of 24 months or longer. The proportion who were both wasted and stunted reduced from 2 per cent at the beginning of the programme to 0.4 per cent at its conclusion, and most of the children of normal height but underweight (low weight-for-age) became normal.

Gwatkin, Wilcox and Wray (1980) found from their review of 10 projects, of which eight included both medical services and nutrition intervention, that nutrition intervention reduced mortality. Five of the projects achieved significant improvements in child growth, as well as mortality reduction, for as little as US$ 1.50 to US$ 7.50 per child per year, although some of the improvement was due to improvements in medical services in project areas (Gwatkin, Wilcox and Wray, 1980:15). Similarly, Jennings et al. (1991) reported many successful outcomes from the 17 programmes reviewed, in particular, success in remedying micro-nutrient deficiencies at very low cost.

Candidates for food supplementation are normally selected on the basis of certain body dimensions, known as anthropometric measurements. Jennings et al. (1991: 10) found that in most of the 17 studies they reviewed the anthropometric measurements were derived from growth monitoring, and hence could be interpreted in the light of growth trends. However, in other cases, and especially in crisis situations, many of the candidates for intervention have not had the benefit of growth monitoring. In these instances weight-for-length or arm circumference is commonly used, a cut-off point is chosen, and children whose measurements fall below the cut-off receive supplementation, usually on the grounds that they have an enhanced risk of mortality and physical impairment relative to those above the cut-off point (Beaton et al., 1990: 27). Without information on children's growth trends in the preceding months, the use of cut-off points to classify levels of risk is at best rough, and may miss high-risk cases. There is thus a need to identify other indicators of risk which could be used to augment cross-sectional anthropometry when growth monitoring is not available. This could improve the identification of candidates for intervention, not only in crisis situations but also whenever children who have not previously been monitored present at a health facility.

The survival capacity of children with poor growth attainment is extremely variable. This is in part due to varying exposure to infection and differences in the care received. Although the relative risk of dying increases substantially at the lower ends of all anthropometric scales, and certain cut-off points are frequently used to identify high-risk cases, there are no recognised points which distinguish children who would certainly die without intervention from those who would certainly survive if their nutrition were supplemented (see Mosley and Chen, 1984: 31; Behrens, 1991: 35). Nor is it possible to quantify the long-term effects on survivors of poor growth attainment.

Martorell and Ho (1984: 49) commented:

> *There is no need for further studies to show that severely malnourished children are at greater risk of dying than healthy children. There is a pressing need, on the other hand, for investigations that focus on the survival of children suffering from mild and moderate malnutrition.*

In particular, there is a need for clinical studies which assess the impact of food supplementation on mild to moderately malnourished children and determine what level of malnutrition has significant implications for health in later life. However, there is also a need for studies which focus on the socio-economic, demographic and environmental characteristics which predispose mild and moderately malnourished children to become severely malnourished.

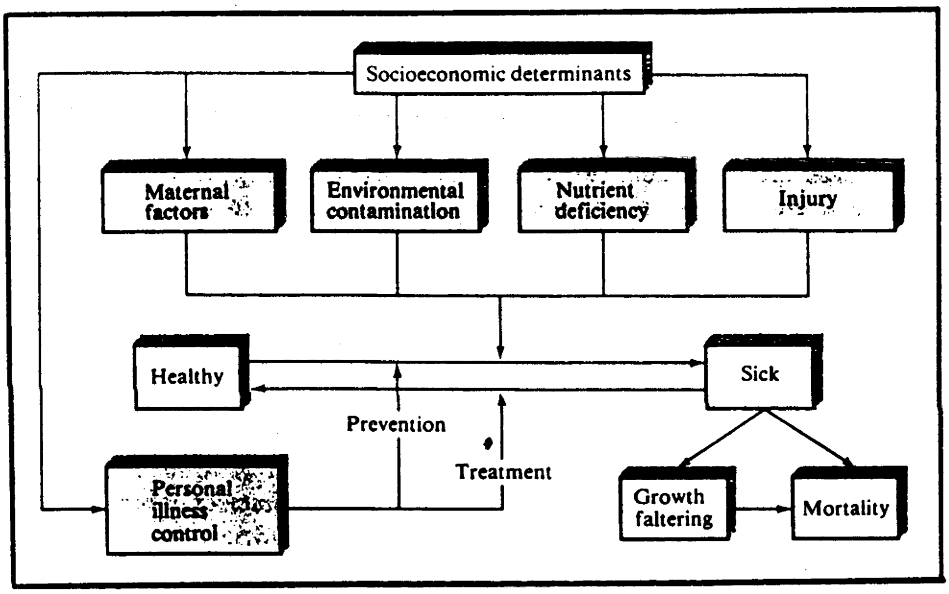
The scarcity of information on these topics is due in part to the high cost and complexity of long-term, prospective, health monitoring projects. Some well known examples are those carried out in Kenya (van Ginneken and Muller, 1984), the Gambia (Tomkins et al., 1986), Guatemala (Mata, 1978) and India (Kielmann and Associates, 1983). However, in addition to being expensive, these studies have demanded long-term commitments of time and skilled manpower. Although they have provided much of the present day knowledge on the correlates and processes affecting child health and survival, they are few in number and tend to deal with fairly homogeneous samples. In fact, the difficulties of carrying out the meticulous research needed to quantify precisely the relationship of malnutrition, infection and mortality are such that it is not realistic to expect conclusive findings in the near future.

While cross-sectional studies are not able to fill this gap in knowledge, they are nonetheless a potentially valuable source of information for future epidemiological studies. Cross-sectional survey techniques have the capacity to collect a wider range of information from a larger sample of respondents than is practical in longitudinal studies. In particular, they support the identification of significant associations between family and environmental characteristics and child health and survival. By pointing to possible causal linkages which contribute to differentials in survival and growth attainment, such research provides essential background information for more detailed, longitudinal studies.

In recent years it has been recognised that child survival and growth attainment are determined by a large number of factors which, in the past, were treated separately as the subject of either medical or sociological research. Mosley and Chen's (1984) influential paper drew attention to the interaction of socio-economic, environmental and maternal factors, nutrition, injury and health care on child survival. As well as pointing out that child survival is at the interface of medical and social science, it paved the way for different types of research to contribute to knowledge of the topic.

Mosley and Chen's (1984) model belongs to the general class of models in which background variables exert their influence through intermediate, or proximate, variables which have a direct effect on the outcome. This approach was first used by Davis and Blake (1956) to analyse the determinants of fertility. Mosley and Chen's conceptual framework identifies five groups of proximate determinants of the health and survival of young children (see Figure 1.1). Socio-economic factors are portrayed as the underlying influences which determine child survival. They act through a series of proximate determinants: maternal factors, environmental contamination, nutrient deficiency, injury and personal illness control, which directly affect the health of a child.

Figure 1.1: MOSLEY AND CHEN'S ANALYTICAL FRAMEWORK



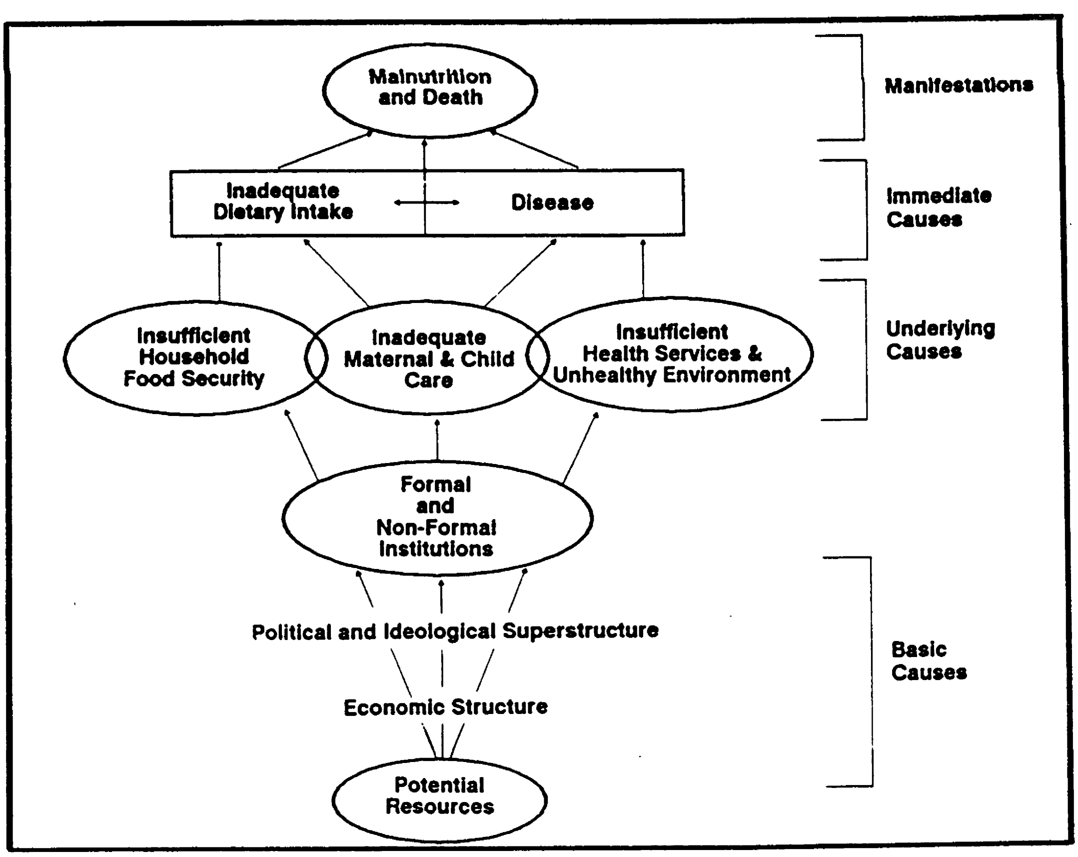
This model has been widely applied, particularly the concept of proximate determinants, and remains a very useful starting point for studies of child mortality. However, it is not wholly appropriate for studies of the survival of malnourished children. Because of its primary concern with child mortality, the only measure of malnutrition included is growth faltering, which is depicted as an outcome of sickness. It does not consider other important indicators of poor nutrition, such as stunting and underweight, which are not necessarily an outcome of sickness, or which may be caused by a combination of sickness and other factors.

In order to fully appreciate this point it is important to distinguish between growth faltering and growth attainment. Growth faltering is a process, discernible only from a series of observations over time. Although child growth is often erratic, as discussed in Chapter Five, growth faltering is said to occur when growth slows or stops for a sustained period. It is often a precursor to death.

On the other hand, growth attainment is a point measure of actual growth achieved. Usually it is expressed in relation to a reference standard, either population specific or general. Growth attainment may be above or below this standard. Many children in developing countries grow very slowly and have poor growth attainment. Compared with usual reference standards they may be stunted and underweight, but they do not necessarily experience growth faltering, serious illness or death. It is thus apparent that a model which focuses only on growth faltering is not a suitable starting point for a study of survivors.

Another framework is that proposed by UNICEF (1990: 22) to incorporate 'multisectoral components' into studies of malnutrition and death (shown in Figure 1.2).

Figure 1.2: THE UNICEF ANALYTICAL FRAMEWORK



This model also brackets the two outcome variables together, as does that of Mosley and Chen, but does not specify exactly what is meant by 'malnutrition'. It can only be assumed that, since it is depicted as an outcome of sickness, it must be growth faltering. This model reaches beyond socio-economic factors to include the political, ideological and economic superstructures as the 'basic causes' of malnutrition and death. Insufficient household food security, inadequate maternal and child care, insufficient health services and an unhealthy environment are the 'underlying causes', and inadequate dietary intake and disease the 'immediate causes'.

The wider conceptual basis of the UNICEF model is useful, as it draws attention to the contribution of underdevelopment and poverty at the national level. However, since many of these concepts are broad and not easily measured, it is impractical to use this model as a framework for a detailed study of poor growth attainment based on survey data.

In addition to proposing a theoretical framework, Mosley and Chen (1984: 30) also pose the question of 'how to combine counts of the dead with observations on the living into a unified scale or index of the health status of a population'. They suggest this can be achieved by extending the Gomez classification of malnutrition to a fourth grade, that of below 40 per cent of standard weight-for-age, and assigning dead children to this grade. Using data from prospective studies in Bangladesh, India and Papua New Guinea plotted on a logarithmic scale, they identify a consistent increase in risk of death as weight-for-age declines. Their assumption that dead children should be placed in Grade Four derives from the fact that none of the living cases in the three studies were below this level, while USA neonates below this level had an elevated risk of mortality.

Although this classification achieves the stated objective of a continuous 'health status index' for both living and dead children (Mosley and Chen, 1984: 30), it claims a level of precision which may not be warranted. As Mosley and Chen (1984: 31-32) themselves state in the same paper,

> *the probability of dying at a given level of growth faltering varies greatly between populations according to the prevalence of certain diseases and the availability of medical services...(some countries) have documented mortality decline without a significant change in the 'nutritional status' of survivors .*

It is apparent that variation occurs not only between populations but also within populations, and that a host of factors affect the probability of dying. While it may be appropriate to place deaths from diarrhoea in a fourth category on the Gomez scale, deaths from other conditions, such as neonatal tetanus, do not necessarily have an association with poor growth attainment. Similarly, although malnutrition may increase the risk of dying from diseases such as pneumonia, measles, polio, TB and pertussis, children who are well nourished are also at risk. To put the point in simple terms, although malnutrition is associated with elevated risks of mortality, not all children who die are malnourished, and not all malnourished children die.

Simply equating levels of malnutrition to relative risk of mortality on a continuous scale may overlook characteristics which point to an elevated risk for some mildly malnourished children. Thus, as discussed above, there is a need for research on the survival of malnourished children and the characteristics which distinguish those who have an elevated risk of mortality compared to others. Ideally this should be achievable from as few measurements as possible, as the majority of children in developing countries do not have the benefits of continuous growth monitoring to identify the process of growth faltering.

1.2. RESEARCH OBJECTIVES

This study has three main objectives. The first is to refine the theoretical framework for the study of growth attainment. The second is to evaluate the utility of cross-sectional surveys such as Demographic and Health Surveys (DHS) as sources of data on child mortality and growth attainment, and to explore techniques for analysing them. The third is to compare patterns and correlates of mortality and poor growth attainment across several countries, with a view to identifying common characteristics which enhance the risk of mortality among children with poor growth attainment.

1.2.1 Refinement of the theoretical framework

The first objective will be met by proposing some modifications to the Mosley and Chen framework to make it suitable for the study of two health characteristics of survivors: condition at birth and growth attainment. The theoretical framework for the study of poor growth attainment is not well developed. Much of the anthropometric literature, which is reviewed in Chapter Five, is concerned with measurements and their interpretation. It is more common to view growth attainment from the scientific perspective of the nutritionist than to take a socio-medical approach. There has been only limited attention to the development of a theoretical framework which incorporates various groups of factors and attempts to explore causality. The few studies which do use a theoretical framework tend to use the Mosley and Chen model.

The starting point for this investigation is two models, proposed in Figures 1.3 and 1.4. One is for neonatal survival and one for post-neonatal and child survival. Although the structure and some components are derived from Mosley and Chen's model, there are several important differences. Although variables are grouped into general categories, with some groups acting through others, and others acting both directly and indirectly, it must be emphasised that the groupings are primarily to simplify description. They are not intended to signify rigid boundaries, and, as will be shown, some variables may act in several different ways.

The neonatal model has survival status as its outcome variable. The underlying determinants are socio-economic, environmental and demographic factors and ante-natal care. This differs from Mosley and Chen's model, which classifies only socio-economic factors as underlying while the rest are intermediate, or proximate determinants. This is a more realistic representation, because these factors are interrelated in complex ways and it is sometimes difficult to say which is underlying. The causal paths will be examined wherever possible in this study.

The intermediate variables are genetic factors, ante-natal care and maternal factors. The last of these includes maternal health and all aspects of pregnancy, including duration. These variables determine the condition of the infant at birth, which in turn determines survival. Condition at birth includes birthweight; respiration, circulation and other functions as measured by the APGAR score[1]; and whether or not the child contracts neonatal tetanus. Genetic factors include congenital deformities as well as inherited characteristics, such as growth potential. As noted in the figure, several of these groups of variables are not available in the data sets used for this study, so their influence must be inferred from the unexplained variation between cases.

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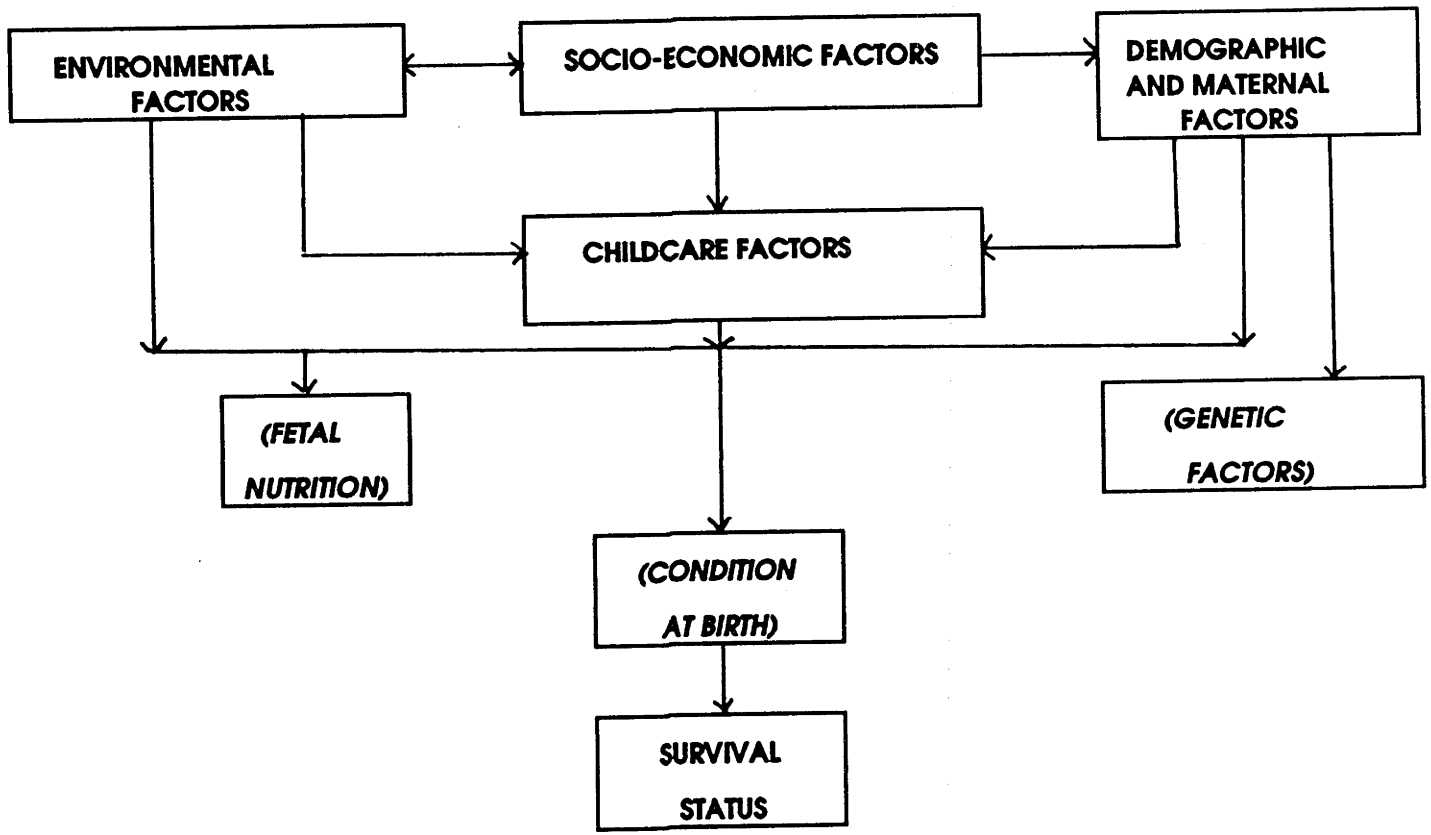
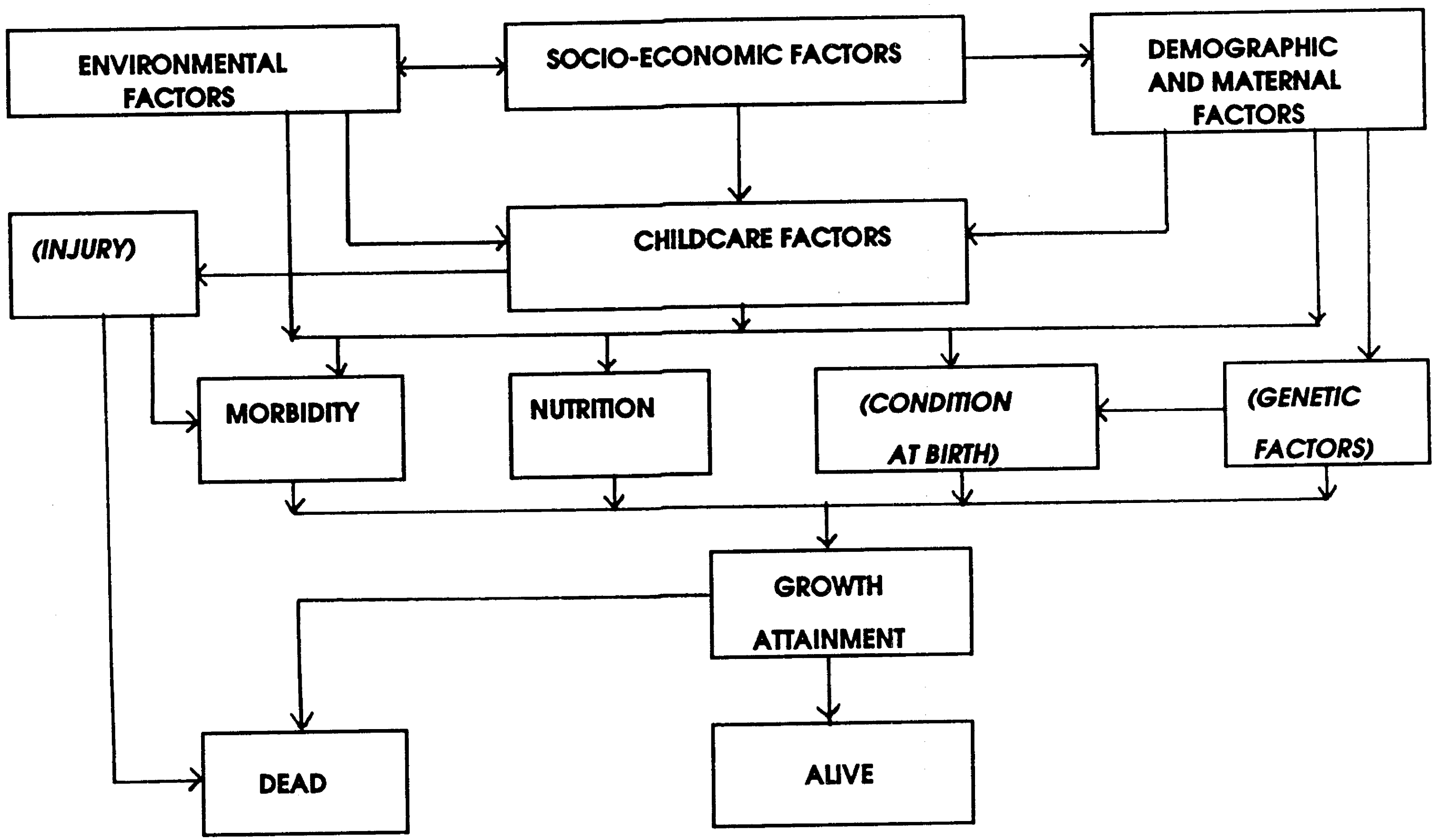
1 An index which measures colour, respiration and reflexes at fixed time intervals after birth.

Figure 1.3: A CAUSAL MODEL OF NEONATAL SURVIVAL



( ) = Data not available for this study.

Figure 1.4: A CAUSAL MODEL OF GROWTH ATTAINMENT



( ) = Data not available for this study.

The post-neonatal and child model is more complex, as it serves as a basis for investigating both growth attainment and survival. The underlying factors are the same as in the neonatal model, with the addition of injury. The intermediate variables are morbidity, nutrition, genetic factors and condition at birth. It can thus be seen that the first model leads into the second at this point.

It is argued here that these intermediate variables act in combination, and it is rarely possible to separate their effects. As only limited data on morbidity, nutrition and condition at birth are available for the present study, and no data on genetic factors, no attempt will be made to measure their independent effects and interactions. Instead they will be treated as a single entity.

In this model, growth attainment may be considered as either an outcome variable or a determinant of survival status. As discussed above, growth attainment is conceptually different from growth faltering, and in the majority of cases is not linked with mortality. Death, which is always an outcome variable, is directly affected by injury, but can be affected either directly or indirectly by morbidity. A direct effect occurs when a child with satisfactory growth attainment dies suddenly from a severe infection. An indirect effect occurs when morbidity acts with other intermediate variables, including nutrition, over a longer time period. This results first in poor growth attainment and then in death.

Whereas Mosley and Chen's model polarises sickness and health and considers only poor growth (growth faltering) as an outcome of sickness, this model uses the continuum 'growth attainment'. It is thus suitable as a starting point for studying the growth of both healthy and sick children, and can be used with both cross-sectional and prospective data. It also provides a more appropriate framework for analysing the correlates of child survival when only limited data on morbidity are available.

1.2.2 Evaluation of the utility of DHS for the analysis of the correlates of child mortality and growth attainment and exploration of techniques of analysis

The evaluation of DHS data is on-going throughout this study. It has several aspects. The first is an assessment of the plausibility of the anthropometric patterns observed in the three countries. The second is an assessment of the plausibility of the patterns of correlation with mortality and growth attainment. The third is an assessment of the limitations of DHS for the analysis in this study.

A variety of techniques for analysing cross-sectional data on growth attainment are explored. These include techniques for comparing national patterns of growth attainment with international reference data, and techniques for comparing the growth attainment of siblings. This study also explores the use of cut-off points in anthropometric data, and compares methods of analysis based on cut-off points with those which treat growth attainment indices as interval variables.

1.2.3 Cross-country comparison of patterns and correlates of mortality and growth attainment

Poor growth attainment is the most readily measured symptom of malnutrition, which is widespread in developing countries. Although most children who die have poor growth attainment immediately before death, many children with poor growth attainment survive to adulthood. As discussed above, nutrition intervention programmes commonly rely on one-off measurements as the criteria for inclusion of cases, although, as shown in Chapter Five, the cases selected may vary depending on the indicator used. There is therefore good reason to undertake research which adds to the understanding of the growth patterns as depicted by cross-sectional studies. Moreover, the health implications of mild and moderate malnutrition, as manifested by poor growth attainment, are not well understood. Stunting and underweight are two important symptoms of malnutrition which require more research (Martorell and Ho, 1984: 49).

This study focuses on the association of growth attainment and mortality. Unlike most studies of this association, it uses cross-sectional data on the growth attainment of living children instead of prospective data on growth trends. As measurements were collected only during the survey, these data sets do not include measurements for dead children. However, they do include comprehensive information on the socio-economic, demographic and environmental characteristics of both living and dead children.

In contrast to the Mosley and Chen approach, which treats growth faltering and mortality as two related outcomes of sickness, this study treats dead children and children with poor growth attainment as two discrete groups. Several methods of mortality analysis which control for censoring are used in this study, and a new method to identify clustering of deaths among mothers is proposed and tested. Multi-variate analysis is used to compare the socio-economic, demographic and environmental characteristics of children with poor growth attainment with those of dead children. Similarities and differences in the models are then evaluated to determine whether certain characteristics, in addition to poor growth attainment, could signify a greater risk of mortality for some children.

A comparative analysis of three countries has been chosen for two main reasons. First, it helps to distinguish those differences in survival and growth attainment which are attributable to the particular conditions in a country from those which are due to socio-economic and demographic factors. Second, it helps the identification of common paths of influence.

The analysis has three major components. The first is an exploration of the patterns of growth attainment depicted in cross-sectional survey data for three African countries. The second is a comparison of the factors associated with mortality and with poor growth attainment in the three countries, as manifest by stunting and underweight. The third is an exploration of the extent of clustering within households of poor growth attainment, under-five mortality and, where available, low birthweight.

This study is not able to answer important questions about the long-term survival of mildly and moderately malnourished children or about the implications of poor growth attainment for a healthy life, as such studies require prospective data. The role of injury in child survival and growth attainment also is excluded from the present study as there are no data in DHS surveys. Also, it must be emphasised that this study is concerned only with poor growth attainment as measured by length or height and weight. It does not consider those forms of malnutrition, such as micro-nutrient deficiencies, which do not necessarily manifest in stunting and underweight and can be detected only by clinical assessment. Nonetheless, some of the findings of this study are relevant to future research on these topics.

1.3 DATA SOURCES

The main data for this study are cross-sectional data sets for Burundi, Uganda and Zimbabwe which were collected by the DHS project of the Institute for Resource Development / Westinghouse Corporation. DHS is funded by the United States

Agency for International Development (USAID). The objective of the DHS project is to collect comprehensive data on fertility, family planning and maternal and child health from women aged 15-49, whether married or not (Uganda Ministry of Health and Institute of Resource Development, (UMOH & IRD), 1989: xii). The first round collected data from around 30 countries throughout the developing world. The second round, which includes some re-surveys and some new countries, was nearing completion at the time of writing, while some countries had carried out a third survey.

In each country DHS carried out its survey in collaboration with a government department, usually statistics or health. Samples were designed by an internationally recognized sampling expert, and field staff with local knowledge were used to collect information. Although there are inevitably some biases and limitations, as discussed in Chapter Three, these data sets are widely recognised as among the most comprehensive demographic and health data sources for each surveyed country.

Each DHS questionnaire is built on a basic question module which is common to all countries. This module collects socio-economic data and comprehensive birth histories. The balance of the questionnaire comprises a selection from the modules on other topics, which include family planning, child health, anthropometry, husband's questionnaire, AIDS and country specific questions. The questionnaires are generally translated into one or more local languages, but the standard wording is retained as far as the translation allows. The data sets thus support inter-country comparison.

Burundi, Uganda and Zimbabwe were selected primarily because their DHS surveys included anthropometric data, and because of their common regional location. Although the three countries have distinctive characteristics, as described in Chapter Three, they share some common features and experiences which make a comparison interesting and valid. Each has experienced colonialism and each has suffered major conflict within the past two decades. Compared with West Africa they are relatively free of some of the important tropical diseases, such as *African Trypanpsomiasis* (sleeping sickness), various forms of *leishmaniasis* (skin ulcers) and *onchocerciasis* (river blindness), although malaria is endemic (Schull, 1987). Africans comprise the majority of the population in all three countries, with at least two major ethnic groups in each. Finally, all three have a substantial population growth rate, with a large proportion of the people dependent on subsistence or semi-subsistence cultivation.

Heights and weights were recorded for children aged 3 - 36 months in Burundi, 0 - 60 months in Uganda and 3 - 60 months in Zimbabwe. Similar demographic, socio-economic and health data were collected in all three countries. All three data sets used for the present study were collected in the first round of DHS. The Enquête Demographique et du Santé au Burundi (EDSB) was carried out in 1987 (Burundi, Ministére de l'Interieur and Institute of Resource Development (BMI & IRD), 1988), and the Uganda Demographic and Health Survey (UDHS) and the Zimbabwe Demographic and Health Survey (ZDHS) in 1988/1989 (UMOH & IRD, 1989; Zimbabwe Central Statistical Office and Institute for Resource Development (ZCSO & IRD), 1989).

In addition to the three DHS data sets, this study uses secondary data from published reports of censuses, other surveys and national level assessments of health status by international agencies, such as UNICEF. Field visits were made to each of the three countries to gather published material and background information, to facilitate the interpretation of the data sets. This included discussions with health professionals and mothers of young children. All photographs in this volume were taken by the author.

1.4 ORGANIZATION OF THE STUDY

This study comprises eight chapters. Following this introductory chapter, Chapter Two reviews the theoretical literature on child survival in both a world and an African context, with special reference to the contribution of nutrition and morbidity. Chapter Three presents a brief outline of the geographical, historical, social and demographic features of the three study countries and discusses the nature and limitations of the data sets. Chapter Four is an analysis of child mortality patterns and differentials in the three countries.

Chapter Five begins with a discussion of anthropometric measures and their interpretation. This is followed by an analysis of the patterns of growth attainment in the three countries. Chapter Six examines differentials in growth attainment in the three countries and compares them to the mortality differentials observed in Chapter Four. Chapter Seven builds on the findings of Chapters Four and Six, with an analysis of the extent of clustering of mortality, poor growth attainment and low birthweight within households. Chapter Eight summarises the findings of this study, discusses their policy implications and recommends topics for future research.

CHAPTER TWO: SOCIO-ECONOMIC, DEMOGRAPHIC AND ENVIRONMENTAL CORRELATES OF CHILD SURVIVAL AND GROWTH ATTAINMENT: A REVIEW OF THE LITERATURE

2.1 INTRODUCTION

There is a large body of literature on the effect of socio-economic, demographic, environmental and child care factors on child survival. Most of this literature is concerned with growth faltering as an indicator of an elevated risk of mortality, and pays little attention to the growth attainment of survivors. On the other hand, much of the literature which discusses anthropometry focuses on the patterns and interpretation of growth rather than on the underlying causal factors. There are relatively few studies which consider the correlates of poor growth attainment among the 80 or 90 per cent of children who survive.

The survival and growth of children in the first five years of life are determined by a complex mix of factors, operating at both the individual and the community level. Although high living standards and advanced health technology have reduced under five mortality to below 10 per 1000 in some developed countries (UNICEF, 1993: 69), the majority of the world's children experience higher mortality and poor growth because of their disadvantaged social, economic and environmental conditions. These conditions constrain child-rearing practices at the family level, while the survival probabilities of individuals are also determined by demographic factors, such as birth interval and maternal age. Malnutrition is an outcome of deprivation due to various socio-economic, demographic and environmental factors, and poor growth attainment is one manifestation of malnutrition.

The objective of the present chapter is to provide a theoretical setting, not only for a comparison of the correlates of mortality but also for a comparison of the correlates of poor growth attainment. Accordingly, it reviews the literature on the correlates of child survival, and considers how these factors relate to growth attainment. The correlates of child survival and growth attainment are grouped loosely into the four broad groups depicted in Figure 1.4. Injury is discussed with the group of child-care variables in Section 2.5.

Most of the literature dealing specifically with anthropometry and its interpretation is reviewed in Chapter Five. Chapter Six, which analyses the correlates of poor growth attainment in the data sets, draws on the literature discussed in both the present chapter and in Chapter Five.

2.2 SOCIO-ECONOMIC FACTORS

Child survival is affected by three levels of socio-economic variables: individual, household and community (Mosley and Chen, 1984: 34). At the individual level, factors such as education, religion and occupation both govern the parents' outlook on life and determine their ability to provide food, shelter and care for their children. Certain differences between parents consistently manifest as differentials in child survival. Wealth is classified as a household-level variable which determines the ability of household members to provide for and care for their children. At the community level, less quantifiable factors include the ecological setting, political economy and health system. Most surveys, including DHS, focus on collecting information on factors which operate at the individual and household levels. This review will focus on household and individual variables, while some community-level variables will be considered in Chapter Three's discussion of the geographical and political setting of the three countries.

Many studies have indicated that one of the most powerful socio-economic factors affecting child health and survival is the education level of the mother (for example Cochrane, 1980; Chowdhury, 1982; Martin et al., 1983; Phillips and Mozumder, 1984; Ware, 1984; Mensch, Lentzner and Preston, 1986; Caldwell, 1989; Cleland, 1990). Uneducated mothers tend to bear more children than educated mothers, and their children tend to have a lower probability of survival, as they risk exposure to more hazards such as poor hygiene and health care. Differences in the survival of children of educated and uneducated mothers exist in both developed and developing societies (Cleland, Bicego and Fegan, 1991: 149).

However, the mechanism through which education acts to increase child survival is still a subject of debate. Although many studies have shown that education is positively correlated with use of modern health services, there is no consensus among researchers as to how education achieves this effect, what sort of education, and how much is required, or whether education is merely a proxy for something else (Cleland (1990), gave some examples of differing viewpoints). In part this is because the nature of the relationship between maternal education and health-seeking behaviour is obscured by high levels of interaction between most socio-economic variables. Since educated mothers are more likely to be urban, wealthy and to prefer small families, it can be difficult to distinguish the independent effect of education from the effects of other factors.

There are two main schools of thought on the role of maternal education. One view is that the most important effect of education is a direct effect, in the form of superior child care and health-seeking behaviour of educated mothers. Another view is that education is primarily a proxy for other factors, including better living conditions and higher incomes.

Caldwell (1989: 106) considered that the educated mother is less likely to defer to traditional decision-making patterns, and instead will actively seek out appropriate care for her sick children. Much information about child care is culturally specific, customary knowledge, passed inter-generationally from older to younger women. In some instances the advice given is soundly based in good health practices, but in others the advice may reduce a child's chances of survival. For example, some rural Javanese women regard colostrum as dirty or bad tasting, so express and then discard or bury it (Hull and Simpson 1985: 84). Yitno and Handayani reported that most traditional midwives in Ngaglik, in Java, advise against feeding colostrum (cited in Hull and Simpson, 1985: 84). Instead honey, coconut or lime is given to newborn infants, who are thus deprived of valuable nutrients and antibodies. Educated women are more likely to have the ability to distinguish between sound and unsound practices and to be more willing to act against advice from older women than are uneducated women.

Okojie (1993) reported that in Nigeria both educated and uneducated women used traditional healers and had similar health beliefs, but the depth of understanding, especially of health information campaigns, was greater among educated mothers. This, coupled with their tendency to live in communities with better access to modern health care, led to their greater utilization of modern medical facilities, and to lower mortality of their children. On the other hand, Bhuiya, Streatfield and Sarder (1993) emphasized the importance of education in changing traditional beliefs in favour of scientific beliefs about the causes of disease. Understanding of the aetiology of disease led to better acceptance of healthy practices, such as hand washing and safe handling of food, among women in the Matlab project, Bangladesh.

Singarimbun, Streatfield and Singarimbun (1986) found that well educated women in Indonesia were more likely to have heard of and to understand the purpose of immunization, as well as more likely to consider immunizable diseases dangerous. However, they also found that uneducated women who understood the function of immunization were as likely to immunize their children as were women with more education. Hence the important factor was the understanding of immunization rather than the education level, although educated women were more likely to understand immunization. They also noted that the well educated were likely to use a wider range of health services than illiterate women, to be treated differently by health workers, to be given health information and to complain if the services were not satisfactory. They conjectured that illiterate women were more likely to react to poor service by not returning for further treatment rather than by complaining (Singarimbun, Streatfield and Singarimbun, 1986: 10).

These examples support Simons' (1989: 134) contention that education brings a shift to an 'internal locus of control' that leads a woman to take a more active role in caring for her children more effectively. They also are consistent with Caldwell, Reddy and Caldwell's (1989: 2) view that education has its impact on women by changing the type of people they are rather than by imparting certain information. Mahmud and Johnston (1994: 157) emphasized the role of education in empowering women to mobilise community resources to support women's and children's health.

Cleland (1990: 412) attached less importance to the effect of education on health knowledge and beliefs. He suggested that:

> *...education may have a modest effect on health knowledge and beliefs, but a pronounced effect on the propensity to use modern medical facilities, because of a closer identification with the modern world, greater confidence in handling bureaucracies or a more innovative attitude to life among women who have some experience of school.*

However, another paper by Cleland in collaboration with van Ginneken (1989: 89) cited many studies which indicate that the effect of maternal education is independent of the utilization of modern health care facilities. They concluded that domestic child-care practices are the major mechanism leading to better child health and survival. Caldwell, Reddy and Caldwell (1989: 212) reported that the single most important reason given for sending a girl to school in their rural South Indian study area was that she would be better able to look after the health of her family. Lindenbaum (1990: 430) reported that in nineteenth century Bengal educated wives were valued not only for their household management skills but also because they benefited the next generation by producing healthy children. Caldwell (1989: 107) found also that educated women in South India were more likely to allow sick children to rest. However, it could almost certainly be argued that this was because these women faced less economic pressure and were less dependent on the labour inputs of their children; hence the health of their children was probably equally affected by economic factors.

Hobcraft (1993: 161-163) also emphasized the indirect benefits of maternal education. First, the tendency of educated women to marry later avoids high-risk teenage pregnancies and thus reduces mortality among first births. He estimated that the excess risk of mortality for children of teenage mothers averaged 40 per cent across 25 DHS surveys. Second, the tendency to have fewer births leads to reduced rates of maternal mortality and orphanhood. Third, educated women are more likely to have received antenatal anti-tetanus immunization and prenatal care and to deliver in the presence of trained health personnel. However, it is important to note that Hobcraft's DHS analysis of the association of maternal education of seven years or more with child mortality revealed generally weaker or insignificant effects in sub-Saharan Africa, including Burundi, Uganda and Zimbabwe (Hobcraft, 1993: 164).

Ware (1984: 198) emphasized the importance of education as a proxy for command over resources such as clothing, food, shelter, medical care, sanitary facilities and water supply. Educated women tend to marry wealthier husbands and to live in wealthier households. Sathar (1993: 231) concluded that most fertility differentials according to wife's education can be explained by their residence in urban areas, which increases their likelihood of being married to white-collar workers. Similarly, education may influence child survival largely through its association with higher incomes and better access to health care (Sathar, 1993: 235). Lindenbaum, Chakraborty and Elias (1989: 127) pointed out that schooling itself safeguards young women from doing hard work during their growing years and tends to defer their age of marriage and childbearing. They are therefore less likely to be stunted themselves, and less likely to bear low birthweight babies.

The view taken of the mechanism through which education affects child survival influences decisions to invest in social infrastructure. Preston (1985) argued that since parental education, and especially mother's education, explains much of the rural / urban differential in child survival observed in WFS surveys, investments in medical services in urban areas may have little effect on mortality. However, Caldwell (1986: 202) disagreed with this view, and argued that education should be viewed as the catalyst which ensures optimum use of health facilities. He contended that the dilemma of whether it is better to build a school or a hospital is a false dilemma, since education is a prerequisite for health service utilization, while the absence of health facilities may severely limit the ability of educated parents to care for their children.

Education operates not only at the individual but also at the community level. Caldwell (1989: 103) has shown that differences in the mean societal level of education are more important factors in child survival than differences in the mother's personal level of education. That is, a woman with a low level of education in a society where the mean education level is high is likely to have a better experience of child survival than a highly educated woman in a society where the mean education level is low. This points to an association of higher community levels of education with factors such as better environmental sanitation, better provision of health-care facilities and better nutrition.

From the above discussion it can be concluded that the effect of maternal education on child survival, child nutrition and growth attainment is a combination of both direct effects and proxy effects. On one hand educated mothers are more likely to provide better and safe nourishment for their children and to protect them from infection, while on the other hand educated mothers are more likely to be able to afford to feed their children well.

Education of husbands[1] also has been shown to have a significant association with child survival. However, the direct effects of male education are difficult to distinguish, because in many developing countries the correlation of education with occupation and income tends to be stronger for males than for females. On the basis of data from Sudan, Farah and Preston (1982) concluded that male education is primarily a proxy for

1 This study will refer to 'husband's education' rather than 'paternal (or father's) education'. DHS surveys collected data on the characteristics of the current husband or partner of the respondent, who normally has most influence on family circumstances. In communities where extra-nuptial births and remarriage are common, as in much of Africa, it cannot be assumed that the husband is the father of all children in a family.

husband's income. Tabutin and Akoto (1992: 33) found that the effect of husband's education on mortality varied between the African countries in their study, and was strongest in Senegal and weakest in Ghana and Lesotho. They did not offer an explanation, but possibly it reflects differences in family structure and in the education and role of women in these societies. They concluded from Nigerian data that survival probabilities are better for children who are poor with a literate mother than for those who are rich with an illiterate mother (Tabutin and Akoto, 1992: 39). Mbacke and van de Walle (1992: 125) cited Sulaiman's study of Southern Nigeria and commented that it is possible to distinguish the separate effect of mother's income on child survival in such societies where women keep separate budgets and pay the costs of raising their children.

Regardless of their association with education, economic factors play a critical role in child survival. Preston (1989: 75) pointed out that higher levels of household material resources are associated with lower mortality in virtually every society:

> *More and better food and clothing, more space, more leisure, and better sanitary facilities will produce lower probabilities of dying in any environment.*

Humphrey and Elford (1988) and Himsworth (1989) debated the mechanisms through which social class affects infant mortality, but both agree that a number of factors are involved, including a mixture of environmental factors, competence in child care and genetically determined attributes.

Millard, Ferguson and Khaila (1990: 288) commented:

> *The ultimate causes of high rates of child mortality revolve around poverty resulting from economic relationships reaching from the community level across national boundaries to the global economic system.*

These causes comprise a variety of social, cultural and economic factors, including political economy, distribution of resources, cash income and ethnicity. Disparities in wealth lead to differences in health at the national, regional and village level. At the community level the proportion of the labour force in agriculture is an indicator of overall economic development, and tends to be negatively correlated with GNP per capita. Commercialization of the agricultural sector affects the nutrition and health of local communities in different ways, depending on how the increased wealth is distributed. For example, Coghill (1987) found a generally positive effect in Kenya, where small-holders were the main recipients of the increased income, whereas Loewenson (1988) found that Zimbabweans working on large scale commercial farms were disadvantaged compared with subsistence farmers.

Macro-level poverty may manifest as an inadequate health infrastructure, while micro-level poverty may prevent a family from obtaining sufficient or nutritious food. UNICEF (1993: 54) noted that, as a group, the countries of sub-Saharan Africa spend 50 per cent more on servicing national debts than on the health and education of their children. Moreover, poverty in sub-Saharan Africa has limited the ability of nations to import food to protect their populations from the effects of famine and crop failure (Administrative Committee on Coordination - Subcommittee on Nutrition (ACC/SCN), 1992: 18). Within some African countries the nature of the marketing system may make food too expensive for poor families, but state interventions such as subsidization of food prices tend not to benefit the poor (Sahn, 1992: 21).

At the household level the relationship between wealth and child health is not always directly related to income. Castle (1993) found a complex relationship in Mali between household wealth categories, mother's status and child health, as measured by growth attainment and episodes of illness. Although there was no clear pattern according to perceived household wealth, children of women with high status in their household were consistently better off than children whose mothers lived with their mother-in-law. She attributes this to the superior ability of high status women to utilize resources for their children's benefit. This is supported by Desai's (1991) finding that, although the nutritional status of Latin American children in consensual unions was lower than that of children with legally married mothers, this was not true of West Africa, where women are commonly engaged in trading and other economic activity. Ferro-Luzzi (1984: 189) found that working class Roman children were on average 4 cm shorter than professional class children of the same age. She comments that it is difficult to explain this difference since there were no significant differences in nutrient consumption.

Schultz (1984: 215) emphasised the need to consider the economically constrained selection of health inputs as well as the biological determinants of health in any epidemiological research. Cost may prevent high-risk groups from obtaining appropriate care, even if it is available. Although the poor are often at greatest risk, they are least able to pay for health services or for the cost of travel to access them.

Jolly and King (1966) plotted contours of equal utilization of health facilities in Uganda. They found a 'distance-decay' factor in which the average number of attendances at aid posts halved with each additional mile, and attendance at hospitals and dispensaries halved every two miles. They attributed this largely to the costs of motor transport. The prospect of even very small fees may be sufficient to discourage the poor from seeking medical help. Streatfield, Tampubolon and Surjadi (1990: 816) reported that, although in Jakarta the importance of taking a sick child to a private practitioner as quickly as possible is well known, lack of money may prevent this. As a doctor may cost the equivalent of three days' average wage, the mother may first attempt a cure with street-stall medicine. Similarly, although hospitals are considered to have the capacity to cure serious illness, cost may lead them to be regarded as a last resort after all alternatives have been tried. However, in other situations where free medical services are available, knowledge and practice of correct health behaviour is not necessarily dependent on control over resources.

Differences in education, occupation and income may also interact to affect growth attainment. For example, Groenwold and Tilahun (1990) found that income and husband's occupation were the major factors associated with the weight and height attainment of children admitted to hospital in Addis Ababa. Generally, differences between agricultural and non-agricultural occupations tend to be particularly pronounced. Prohmmo (1993: Table 8) found that children in Northeastern Thailand whose fathers were employed in agriculture were more than three times as likely to be stunted or underweight as those with fathers in non-agricultural occupations. These examples can be considered to reflect the association of occupation and economic status, since good nutrition depends on food security at the household level.

Religion and ethnicity also have been found to be associated with differentials in child health and survival in some countries (see, for example, Choe et al., 1989; Saw, 1990; Yusuf, 1990). United Nations (1982: 106) pointed out that in sub-Saharan Africa it is often difficult to separate the differential effect of geographical location, ethnicity and religion because of the spatial distribution of various groups. Some religious or cultural values are associated consistently with a particular group throughout the world. An example is the well-known opposition of Roman Catholicism to modern methods of contraception. However, in other instances it can be argued that it is not religion or ethnicity *per se* which has an effect, but that they are a proxy for other socio-economic factors, such as income, education and control of resources. Support for this view can be found in the variations in the effect of belonging to a particular religious or ethnic group. Belonging to the Moslem minority in the Philippines, for example, has different social connotations from being one of the Moslem majority in Pakistan. It is therefore important to look at the implications of these characteristics in the context of the particular group under study.

Not only is there variation in the effects of socio-economic characteristics on child survival, but also changes in differentials are not always proportional to overall changes in mortality (see, for example, Barbieri, 1991; Bicego and Boerma, 1991). Cleland, Bicego and Fegan (1991) compared mid-1970s WFS data and mid-1980s DHS data for 12 countries and concluded that although there had been declines in child mortality of up to 50 per cent, this had not always been accompanied by a reduction in mortality differentials. In particular, the rural / urban differential tended to increase, as did that between primary and secondary educated mothers, while that between mothers with no education and those with primary education was stable. Similarly, they found that the blue-collar / white-collar differential tended to diminish, while that between agrarian and white-collar workers increased slightly in some countries and reduced slightly in others.

To summarize, socio-economic factors are important determinants of child health, growth attainment and survival. They are marked by complex interactions which can make it difficult to distinguish the effect of a particular characteristic. Generally, their impact is as determinants of the resources and care devoted to child rearing and health care.

2.3 DEMOGRAPHIC FACTORS

Many studies have found that demographic factors are associated with some of the most pronounced differentials in child mortality (see, for example, Swenson, 1981; Hobcraft, McDonald and Rutstein, 1983 and 1985; Rutstein, 1983; Pebley and Stupp, 1987; Hobcraft, 1991 and 1992; and Govindasamy et al., 1993). Among the most important are mother's age at child's birth, birth order, length of preceding and subsequent birth intervals, survival status of the preceding sibling and child's sex. There is generally an interaction between demographic and socio-economic factors. Reproductive patterns tend to be determined by family socio-economic characteristics, but may in turn affect the socio-economic status of the family.

The overall mortality risk and the differential risk according to demographic characteristics varies according to the child's age. Often this is due to the interaction of demographic and socio-economic factors. For example, male children tend to have a higher risk of mortality in the neonatal period when biological factors are more important, but the risk for females tends to be greater in the post-neonatal period and in childhood, when socio-economic factors become more important (Waldron, 1983: 147). A common pattern of association between socio-economic and demographic factors is that poorer women with little or no formal education have larger families and shorter birth intervals than wealthier, better educated women (see, for example, studies by Hobcraft, McDonald and Rutstein, 1983 and 1984; Boerma and Bicego, 1992).

Mother's age at child's birth tends to be associated with increased child mortality because of its biological effect. Some mothers may be physically unable to give birth to a healthy baby because of their own immaturity or weakened state (Ayeni and Oduntan, 1978; Aitken and Walls, 1986). In their index of high-risk pregnancy Fortney and Whitehorne (1983: 22) attributed similar levels of risk to mothers aged under 16 and those aged 35 years and over. This is reflected in Majumder's (1989) analysis of WFS data for Bangladesh which showed that, when both preceding siblings were alive, the risk of dying for the index child had a U-shaped relationship with mother's age. However, Majumder also found that when one sibling was dead the risk was positively related to mother's age. He attributed this to deterioration of the intra-uterine or physical condition of mothers with increasing age, which made older mothers more likely to experience multiple child deaths (Majumder, 1989: 228).

Differentials in child survival according to mother's age also may reflect socio-economic factors. Geronimus (1987) pointed out that very young women who become pregnant are less likely to receive adequate care, may be from disadvantaged socio-economic backgrounds and may be less able, or less willing, to care for their child because they are physically immature. Van der Pol (1992: 315) reported that, of the infants in a Yaounde study who received both breast and bottle, mortality was highest among those with young mothers. One of the explanations he offered is that young mothers are more likely to accept unsound advice from older women such as uneducated aunts and grandmothers.

Child's age operates on one hand by determining the child's vulnerability to biological factors, such as depletion, and on the other hand by determining exposure to risk and competition from siblings. For example, infants who are entirely breastfed have less chance of contracting diarrhoea than weanlings who drink water and whose increased mobility may enhance their risk of eating contaminated food (Mata, 1978; Scrimshaw et al., 1983). On the other hand, older children of around five years of age may have developed some resistance to infections. Several of the African studies reviewed by van Ginneken and Teunissen (1992) found that, among young children, those aged from six to 12 months spent the greatest proportion of time ill with diarrhoea, while rates were much lower for children aged from two to five years.

Many studies have shown that length of the preceding and succeeding birth interval appearsconsistently as one of the most influential demographic factors, with short birth intervals associated with significantly increased risks of mortality (see, for example, Wolfers and Scrimshaw, 1975; Carlow and Vaidya, 1983; Hobcraft, McDonald and Rutstein, 1983; Cleland and Sathar, 1984; Palloni and Millman, 1986; Park, 1986). Boerma and Bicego (1992) suggested various paths of influence for this effect, including maternal depletion by frequent births, increased risk of prematurity and low birthweight, impaired breastfeeding ability, sibling competition and enhanced disease transmission, all of which are likely to produce poor growth attainment in the first instance. Winikoff (1983) documented the contribution of short birth intervals to maternal depletion, while Fortney and Higgins (1983: 113) referred to research in Britain that found that perinatal mortality of children conceived less than six months after a birth was twice that of children conceived six to 12 months later. Although their study showed that the perinatal mortality rate climbed gradually for intervals longer than 12 months, they commented that birth intervals of less than three years tend to impact adversely on post-neonatal and young child survival in developing countries.

The spacing of siblings tends to exert a social effect by influencing the care the younger child receives and the level of competition for care (Hull and Gubhaju, 1986: 117). Martin (1979) found evidence of significantly poorer verbal skills and perceptive abilities among nine-year-old children in Singapore who were born within 24 months of their preceding sibling. Competition for maternal care, resulting in a lack of close interaction and mental stimulation, seemed to be a likely cause. Gray (1981) reported a positive association of longer birth intervals and post-partum sexual abstinence with child health.

Hobcraft, McDonald and Rutstein (1985) argued that maternal depletion plays a greater role in reducing the survival probabilities of closely spaced births.

Majumder (1989) concluded that the survival status of the previous child can affect the health and survival of the younger child in different ways. If the preceding child is dead, the younger child has a higher risk of mortality than if its predecessor is alive, because the younger child is exposed to the same factors that caused the previous child to die. On the other hand, if the younger child survives infancy, it eventually benefits from an effectively lengthened preceding birth interval and correspondingly reduced competition for resources of food and maternal care. This reduces both its mortality risk and its risk of poor growth attainment. The age differential occurs because mortality during infancy is influenced mainly by biological factors, and mortality beyond infancy mainly by social factors.

Health and survival also tend to vary between male and female children, with female children usually those most disadvantaged:

> *Simply by being born female, a women is more at risk of falling ill. In addition, being poor and living in a rural Third World country increases that risk.* (Travaline, 1980: 2).

Many writers have shown that female children are less well cared for and suffer excess mortality in some societies (for example, D'Souza and Chen, 1980; Lopez and Ruzicka, 1983; Ware, 1984; Das Gupta, 1987; Basu, 1989a). Majumder's Bangladesh study found that, regardless of the sex of the index child, its risk of dying before age five was 20 per cent higher if its preceding sibling were male than if were female. He attributed this differential to the stronger competition offered by an older male sibling than by an older female sibling (Majumder, 1989: 227).

Gender preferences, especially those of the mother, may have a major impact on all aspects of the care given to a child. Preference for children of a particular sex may not only affect family formation, but also affect the care given to individual children. Muhuri and Preston (1991) concluded that the higher mortality rate among girls with older sisters, and, to a lesser extent, boys with several older brothers, was convincing evidence that parents in Bangladesh endeavour to secure a certain balance between males and females in their families. They attributed the higher mortality to differences in the food and health care given to late-born children, according to their perceived value to the family. Like Bairagi (1986) and Bhuiya (1986) they found some indication that the nutritional disadvantage of females tends to be greater in families with higher socio-economic status than in poor households, and greater among educated mothers than uneducated mothers (Muhuri and Preston, 1991: 430).

Other studies have found that children conceived against their parents' wishes, as well as children not of the desired sex, may be discriminated against to the point of extreme neglect, or even deliberately killed (see, for example, Bhatia, 1983; Sabir and Ebrahim, 1984; Sathar, 1987; Basu, 1989a; Arnold, 1991a).

Differing valuation of children is a factor leading to different patterns of child care (Cleland, 1990: 413). Many writers have noted the superior care taken of male children, particularly in Moslem societies (see, for example, Ware, 1984; Das Gupta, 1987; Majumder, 1989). Girls are generally disadvantaged in nutritional status in Bangladesh (Bhuiya, 1989). Although Bhuiya and Streatfield (1991) found that maternal education improved child survival in that country, they reported that even educated mothers may be less ready to seek health treatment for female children than for male children (Bhuiya and Streatfield, 1991: 263). Sex discrimination against female children is also prevalent in India (Bourne and Walker, 1991).

Mbacke and LeGrand (1991) reported significant differentials in utilization of health services in Mali according to sex. They found that females were less likely to be immunized, and, although neonatal mortality was higher for males, there was excess female mortality after age three months. However, views differ about the existence of sex discrimination in sub-Saharan Africa. Ewbank, Henin and Kekovole (1986: 45) and Gbenyon and Locoh (1992: 248) concluded that sex discrimination in feeding is not a feature of child care in sub-Saharan Africa. Sommerfelt's (1991) analysis of 19 DHS surveys reported gender differences as significant in only two African countries, in which boys had a lower mean growth attainment than girls.

Birth order, or parity, seems to exert both biological and social effects, and is correlated with overall family size. The relationship between infant mortality and parity is typically J-shaped. Swenson and Harper (1979) found that foetal wastage and stillbirth was more common among birth orders one and six than birth orders two and three. Nortmann (1974) argued that the effect of birth order results from underlying biological factors, with higher birth orders at greater risk because of maternal depletion. However, Trussell and Pebley (1984) considered that socio-economic status, short birth intervals and older age may have a confounding effect on this relationship. Moreover, children of middle to high birth orders may experience better conditions in the form of greater amounts of supervision and attention from older siblings, as well as having the benefit of a more experienced mother (Knodel and Hermalin, 1984; Fernandez-Castilla, 1989).

From the above discussion it is apparent that, although some demographic variables may have direct biological effects on child survival, much of their impact is a result of their interaction with socio-economic variables, particularly command over resources. For example, short birth intervals may have little or no impact on child survival and growth attainment in wealthy households, while differentials by sex are greatly diminished where parents value their children equally.

2.4 ENVIRONMENTAL FACTORS

Many communities in developing countries are without safe water and sanitation and have inadequate or crowded housing. Without these basic necessities it is difficult to keep infants and small children healthy. Mothers from low income families in such communities may be unable to produce healthy infants, or to protect them from disease, especially if they cannot afford a nutritious diet.

Murillo-Gonzalez' (1983) Costa Rican study showed that, in both rural and urban areas, malnutrition was confined to families living in certain environmental conditions. These included overcrowding, inferior housing, poor hygiene due to unsafe water and sanitation, lack of electricity, and inadequate health and community services. She argued that such conditions led to particular social behaviours and attitudes, including apathy and an indifference to opportunities for social and economic mobility, which in turn fostered malnutrition and poor health.

Pollution in the form of contaminated water and unsafe disposal of excrement impact on survival and growth by increasing the incidence of infectious diseases. Saunders and Warford (1976) estimated that 60 per cent of all sanitation-related diseases could be prevented by a safe water supply alone, while about 15 per cent can be prevented by improving latrine facilities alone (cited in Hebert and Ssentamu, 1985: 122). In much of sub-Saharan Africa few rural dwellers have access to safe sanitation, and even urban sanitation may be rudimentary. Whittington et al. (1992: 9) surveyed the city of Kumasi, Ghana's second largest city with a population of 600,000, and found that 40 per cent of households used the 400 public latrines scattered throughout the city, 25 per cent had access to water closets shared with other households, and another 25 per cent shared bucket latrines with other households. Most of the bucket waste was emptied into rubbish dumps or streams.

Bateman and Smith (1991) considered that community measures of sanitation are better measures of health risk than individual access, since residents are affected by the waste disposal methods used by their neighbours. Their analysis of the Guatemalan DHS demonstrated that children living in communities with a high level of sanitation coverage have the same low risk of stunting, whether or not they had individual access to a flush toilet. This is supported by Esrey and Sommerfelt's (1991) analysis of Sri Lankan DHS data, which found a stronger association of growth attainment with type of sanitation and water in rural than in urban areas.

These results echo those of Mata's (1985) comparison of two Central American populations with similar levels of food intake. He found that levels of infectious diseases, malnutrition, growth retardation and child mortality were much greater in the overcrowded community with poor sanitation than in the community with better living conditions.

Eveleth and Tanner (1976: 89) cited Nigerian data which indicate the overwhelming effect of environment on growth attainment. Whereas well-off Nigerian children were comparable to Europeans, one-year-old children in the slums were comparable with six-month-old well-off children in weight and nine-month-olds in height. Although variation in growth is normal in any population, most studies have found that the mean attainment of the better-off groups is consistently higher than that of populations living in deprived circumstances.

Mesle and Vallin (1993) emphasized the positive effect of industrialization in lowering infant mortality in Western cities. The main negative effect is the increase in degenerative diseases and accidents, which are more likely to affect adults than children. However, water, sanitation and living conditions are not necessarily improved by urbanization and modernization. Jozan (1993) pointed out that, although the industrial revolution was associated with mortality declines, industrialization may have negative effects on health through pollution and congestion. Murthy (1993) argued that while rapid industrialization may have improved the economy of Indian cities, it has brought few health benefits for the majority of urban dwellers. His list of negative effects included congested and dangerous transport systems, slums and squatter settlements, contaminated water supplies, unsafe sanitation, inadequate health care facilities, pollution and increases in the incidence of contagious diseases. Kibel (1991) emphasized the contribution of industrial pollution to increased rates of asthma among South African children in urban areas. He also mentioned decaying housing in slum areas causing lead pollution and 'sick-building syndrome', resulting in a range of infections and toxins as well as enhancing the transmission of viruses.

Sastry, Goldman and Moreno (1993) found that in Northeast Brazil mortality differentials according to rural or urban residence were negligible, but there were distinct differences according to characteristics of the community. Differences between municipalities were associated with factors such as the type of sanitation and water supply, housing, income, and number of hospital beds.

Rutabanzibwa-Ngaiza, Heggenhougen and Walt (1985: 7) claimed on the basis of data from WHO/Africa Regional Office (AFRO) technical reports, that, for Africa as a whole, the percentage of urban dwellers with access to safe drinking water fell from 68 in 1975 to 49 in 1980, and that for rural populations from 25 to 9 per cent. They also claim that this spectacular decline was paralleled by a decline in the percentage with access to safe disposal of human excreta, from 75 to 73 per cent in urban areas and from 30 to 5 per cent in rural areas. They do not discuss reasons for this rapid rate of deterioration. Whether or not these astonishing figures are considered plausible, most would agree with their comment that inadequate sanitation undermines the essential role of women as health-care providers.

The effect of household water and safe sanitation on health varies from one community to another. Diame, Ndiaye and Airey (1990: 55) reported no significant difference in incidence of diarrhoea in rural Senegal according to toilet facility in their analysis of 1986 DHS data, but urban children in households with a flush toilet were significantly less likely to have had an episode of diarrhoea in the two-week reference period. They could not compare the effects of piped water, since few rural dwellers had access to this facility. In fact, Senegalese urban dwellers with both piped water and a flush toilet in their household are likely to be privileged in many respects. The type of water and sanitation may make an important contribution to health, but the contribution of education, occupation and income could be greater. In their analysis of the 1986 Liberian DHS data Conteh, David and Bauni (1990) found that drawing household water from a river or stream was associated with a 30 per cent higher risk of childhood mortality. The differential effect of type of toilet facility was insignificant when the effect of water supply was controlled in their analysis (Conteh, David and Bauni, 1990: 144).

One reason for the small or insignificant differential by type of toilet reported in many studies is unobserved variation in the condition of the facility. Although flush toilets are generally associated with safe sanitation, other factors such as the number of users, whether or not the toilet is functioning correctly and whether or not it is used correctly are important. My observations of flush toilets in various African and other developing countries suggest that a non-functioning, flooded, blocked or leaking flush toilet may pose a considerably greater health risk than a pit latrine or even no facility at all.

Some researchers argue that increasing the quantity of water available brings greater health benefits than improving quality because it leads to an improvement in general hygiene.

> *It is difficult to tease out the two impacts (of water quality and domestic hygiene), but the most important factor appears to be changes in people's hygiene...Washing with soap may be the most cost-effective diarrhoeal control method there is.* (Robson, 1990: 21).

Regardless of water quality, it is possible to reduce the risk of water-borne disease if household water is boiled. Similarly, the health risks from unsafe garbage and excreta disposal can be substantially reduced if hands are washed with soap after using a toilet and before contact with foods, if fruit and vegetables are washed and peeled, and if other foods are cooked at high temperatures and then protected from flies until eaten.

The consumption of foods and liquids other than breastmilk increases a child's risk of infection in virtually every society. Motarjemi et al. (1993) reviewed a number of studies of weaning foods which showed remarkably high levels of contamination in many developing countries. Sources of contamination included use of polluted water in food preparation, domestic animals, unclean utensils, hands contaminated with excrement and bacteria, flies, dust, dirt and insufficient reheating of stored foods. Simango (1988) tested 222 samples of weaning foods and liquids offered to Zimbabwean children and found that, overall, 17 per cent were contaminated with *E. coli*. This percentage varied between different types of food, with vegetables, milk and oral rehydration solution most likely to be contaminated. Simango also found differentials according to the type of vessel used to store food, with bowls, plastic bags, clay pots and bottles more likely to be associated with contamination than cups and cooking pots. Pertet et al. (1988) analysed weaning foods in Kenya and found *E. coli* present in 15 per cent of 738 samples tested. Whereas only 13 per cent of freshly prepared samples were contaminated, the level increased to 18 per cent of samples stored 12 hours or longer before consumption.

Yet although food may be made safe by a few relatively simple measures, they are unlikely to be implemented satisfactorily without an awareness and understanding of sources of contamination. Effective implementation also requires a belief that, by their own actions, individuals can enhance health and diminish the risk of illness (Simons, 1989: 132). This is more common among educated than uneducated mothers.

There is also an economic cost associated with practices to reduce environmental contamination. Poor families may not be able to afford fuel for boiling water and cooking food, safe storage facilities, or soap. Inferior housing offers little protection from contamination by flies and scavenging livestock. It is thus apparent that environmental contamination is interlinked with socio-economic factors operating at the household level, and also with the provision of facilities at the community level.

It is usually expected that the quality of the environment will vary between rural and urban areas, and that urban areas have the advantage of better facilities. Urban residence is usually associated with socio-economic advantages. For example, Tawiah (1989) found substantial differentials in both mother's and husband's education and occupation between rural and urban areas in Ghana. In Sommerfelt's (1991) analysis of DHS data, mean height-for-age of urban children was greater than that of rural children in all but three of the 19 countries reviewed. However, while wealthier urban dwellers may benefit from improved facilities, the poor may experience crowded and polluted conditions which are inferior to those in rural areas (Tabutin and Akoto, 1992: 47). Rural dwellers may have better access to nutritious food and tend to breastfeed longer, which could lead to better growth attainment of their children compared with some urban children. This could offset the effect of their inferior access to modern health care facilities.

Another environmental factor which affects survival and growth attainment is climate. Seasonal differences can lead to variation in the availability of food and water, which may manifest in seasonal differences in mortality and morbidity (Chao and Merritt, 1991). Fargues and Nassour (1992) found marked variation in mortality in Bamako, Mali, where the risk of death at all ages except the first day of life followed a curve more or less parallel to that of the average temperature. The warmest months were the most deadly, since they offered the best conditions for infection. Mortality of children aged 1-4 years was three times as high in the hottest months as in the temperate months (Fargues and Nassour, 1992: 103).

Although region of residence is usually classified with socio-economic variables, among the poorer populations of developing countries its effect is largely as a determinant of environmental quality. The climate, altitude, soil types and agricultural patterns of a region determine its disease pattern and food availability. Although higher incomes in developed countries allow residents to procure similar foods and health care wherever they live, the lifestyles of the majority of residents of developing countries are profoundly affected by local environmental conditions.

Many studies have shown marked regional variations in disease patterns, child growth attainment and child survival (see, for example, McCance and Rutishauser, 1975; Bhattacharya et al., 1981; Mengistu, 1989; World Bank, 1991). Langlands (1975) reported substantial regional differences in disease patterns and nutrition in Uganda, as a consequence of different physical environments and different cultivation practices. Similar reports of differentials in regional characteristics by Nkurunziza (1991) for Burundi and Chavunduka (1982) for Zimbabwe are echoed in the UNICEF (1985 and 1988) overviews of disease and nutrition patterns in the two countries. Climate and variations in cropping patterns and soil productivity are of particular significance in determining regional environmental quality.

The preceding discussion has highlighted the role of environmental factors in child survival and growth attainment. However, it is important to remember their interaction with socio-economic variables, in particular with education and control over resources. Susanne (1984: 76) pointed out that environmental differences in growth attainment are due 'not only to social differences between families, but geographical factors will contribute as well as income, religion or subculture, schooling, and other more subtle familial factors'. Pant (1991) pointed out that access to toilet and electricity are proxies for household socio-economic status in his study of Nepal, and their effect in lowering infant and child mortality is complementary. On the other hand, education may help to offset the effects of poor environmental conditions if informed mothers adopt precautions such as boiling drinking water, storing food safely or obtaining anti-tetanus immunization while pregnant. However, the extent to which they can protect their children against adverse environmental conditions is ultimately determined by their control over resources.

2.5 CHILD-CARE FACTORS

As discussed in Section 2.2 above, education and other socio-economic characteristics have an important role in determining health service utilization and the type of care given to children. This section focuses on the determinants of differential child care and the mechanisms by which different child care practices and health service utilisation affect child survival and growth attainment.

2.5.1 Health-care behaviour

Figures 1.3 and 1.4 show how the care given in the antenatal period has a direct effect on neonatal condition, and an indirect effect on the growth attainment and morbidity risks of children aged from 1-60 months, as it influences the health status of the child at birth. As noted by DaVanzo (1984: 310), children's health prospects partially depend on the 'health capital' with which they are endowed, such as birthweight and condition at birth. The intervention of antenatal care can help optimize this health capital by monitoring foetal growth and identifying high-risk pregnancies (Thomson, 1976; Institute of Medicine, 1985). Medically supervised deliveries improve the survival chances of children with low birthweight and/or a poor condition at birth (Stewart, Reynolds and Lipscomb, 1981: 1040).

The antenatal visit to a doctor, midwife or clinic is, ideally, the point at which the individual first comes into contact with health services. As well as monitoring the growth of the foetus, its position in the womb and detecting symptoms of complications, antenatal services may provide anti-tetanus immunization, advice to the mother on proper diet during her pregnancy and on breathing techniques for the delivery. Srivastava and Saksena (1981) concluded that antenatal care reduces perinatal mortality, although the relationship they found in their sample of 5506 deliveries in Uttar Pradesh was not statistically significant. Potts, Janowitz and Fortney (1983: xii) and Sanie and Surjadi (1987: 2) considered that lack of maternal care is an important cause of high levels of infant deaths, especially from neonatal tetanus, and maternal mortality.

Stewart and Sommerfelt (1991) reported large differentials in the use of prenatal care in Bolivia, Egypt and Kenya, both within and between countries. They reached the interesting conclusion that whereas primiparous women were more likely to receive care than others, adolescent mothers were at greatest risk of receiving no maternity care. This can be explained by the tendency for primiparous women as a whole to be better educated and more modern in outlook because they are younger, while adolescent mothers may not have received the full benefit of education and may try to conceal their pregnancy if it is illegitimate. Filippi, Graham and Campbell (1991: 1721) cited studies which indicate that older women with higher parity are likely to use prenatal services less frequently, because they have more confidence and experience, as well as more responsibilities.

In high-technology environments it is possible to monitor the foetus closely and even to perform complex surgical procedures *in utero*, such as heart surgery, to forestall post-natal problems. However, even in low technology societies, potential problems with the delivery and some infant health problems can be identified. Anderson and Staugard (1986: 86) observed traditional midwives in Botswana performing massage to turn the foetus and rectify presentation problems. These midwives also gave sound dietary advice to expectant mothers and encouraged them to obtain anti-tetanus immunization. Williams (1973: 750) commented that midwives were invaluable for their local knowledge and the confidence they inspire, as well as for their skills. Adetunji (1992) found that midwives in the Christian 'faith clinics' in a Yoruba community were observing sound hygiene principles during delivery and providing a more attractive service than that offered by the medical centre, because they fed and cared for the mothers afterwards. On the other hand, Bhatia, Chakraborty and Faruque (1979) reported that the dietary advice given to mothers by traditional midwives in Bangladesh was often inappropriate for foetal health, as it was intended to retard growth for the sake of reducing delivery complications.

It is thus important to look at the customs, beliefs and practices associated with birth in each society, as it cannot be assumed that modern health care is always more beneficial in terms of child health outcomes. For example, Anderson and Staugard (1986) found that some traditional birth attendants gave equal or better care during deliveries than staff at modern health clinics. Araujo et al. (1983) reported on a successful training programme for traditional birth attendants in Forteleza, Brazil which added to their skills in obstetric care. In contrast, in Bangladesh, Lindenbaum (1990: 435) found that even in a modern context traditional beliefs about hygiene impaired the effectiveness of treatment. Medical assistants and female welfare visitors considered that the surgical gloves used for IUD insertions and pelvic examinations protected the paramedic against pollution rather than the patient from infection, so reused gloves on different patients. She also reported that since birth was viewed as a polluted state, attendants may wash their hands after, but not before, the delivery. In the same country a homeopathic practioner, believing that disease can be transmitted only from a lower caste woman to a higher caste woman and not vice versa, reused intravenous needles from higher caste women, but never the reverse (Lindenbaum, 1990: 435).

New-born infants are totally dependent for their survival on their carers. This dependence persists throughout early childhood, even after they have learned to walk and speak. Child care thus requires very large inputs of time from the mother or another carer. Morever, it is well established that in addition to attention to their physical needs, children need affection and physical contact from other human beings to ensure their emotional well-being, which in turn affects their physical development (Black et al., 1979; Khan, 1979). Dodge (1983: 3) cited studies which found that emotional deprivation in otherwise well nourished children may inhibit the secretion of growth hormones. Children thus affected can experience catch-up growth when their environment improves. The carer's attitude and commitment to the child and the decisions they make about its care, feeding and treatment are thus crucial in determining its health, growth and survival.

Differential treatment of one child relative to another makes a substantial contribution to higher infant mortality rates (IMRs) in some communities. Renne (1993) presented qualitative evidence from Itapa-Ekiti, a Nigerian community, that fostered children are perceived as less well cared for than children raised by their natural parents. She does not discuss the issue of whether female children are more likely to be fostered than male children, but it is interesting that there are substantially more cases of fostered females in all of the tabulations in her paper. Bledsoe (1990) also reported differential care of children of previous unions and illegitimate children in several African countries.

Scrimshaw used the term 'parental underinvestment', to describe the selective giving of time, resources, care and love to some children rather than others, and considered that in large families it results in the survival of those children who provide most benefit to the family. Scrimshaw's theory was primarily concerned with the differential treatment of male and female children, but Ballweg and Pagtolun-An (1992: 131) conjectured that it may apply to children with disabilities and children who were not wanted. In their analysis of a sample of ever-married women from Northern Mindanao in the Philippines, Ballweg and Pagtolun-An constructed a composite variable to measure parental underinvestment, which included antenatal care, breastfeeding, supplementation, utilization of medical services, and the nurture and care given to each child. They found that parental underinvestment substantially increased the odds of a child having died, but the odds increased only a little for children said to be unwanted. The factors most strongly associated with mortality were health factors, including frequency and length of illness. It would have been interesting to see the effect of parental underinvestment where growth attainment was the dependent variable.

Mhloyi (1991) argued that differential care is less common in Africa than elsewhere because the relationship between mothers and children tends to be fluid. She cited numerous studies which document the low levels of face to face contact between mothers and children in Central Africa, where small children are typically carried continuously in slings on their mother's back, and are usually breastfed on demand (see frontispiece). As the mother has her hands free, she is able to perform other activities during much of the time she is caring for her child. Older children learn to feed alone, often reaching round to the mother's breast without moving from the sling. Mhloyi claimed that this weakens the bond between the mother and the child and allows for some 'interchangeability' between children. She suggested that this may be, in part, a natural adaptation to the high levels of child mortality which have pertained in these societies in the past. Mothers become accustomed to the presence of a child in the sling rather than to the identity of an individual; that is, the mother needs to have 'a' child rather than 'a particular' child (Mhloyi, 1991: 7).

The role of accident and injury in child survival is obvious, but, presumably because of its random nature, it is the area given least coverage in the child survival literature, and is rarely asked about in demographic and health surveys. However, it is apparent that the negligence of carers who allow children to stray into dangerous situations can render ineffective even the best of health care and nutrition practices. For example, in 1989 in an Australian Aboriginal community in Queensland, Australia, close monitoring of all pregnancies and the delivery of all babies in hospital totally prevented perinatal deaths. However, three children subsequently died in infancy, one from burns, one from a motor vehicle accident and one from the accidental dislodging of an intravenous tube during an illness (A. Dugdale, personal communication).

Motor vehicle accidents are the leading cause of death of South African children aged one year or more, with the death rate from this cause more than three times that for the United Kingdom (Kibel, 1991: 10). Young children adapt poorly to heavy traffic environments. Their short stature limits their ability to see on-coming traffic, they may be unable to locate the source of sounds, and they are easily distracted. The risk of accident tends to be inversely related to socio-economic status. Dangerous features of disadvantaged communities commonly include an absence of footpaths, lack of electricity, necessitating open fires and paraffin lamps, and stress due to overcrowding (Kibel, 1991: 10).

In some cases children's health may be placed at risk because of injuries inflicted for cultural reasons, which are not perceived as negligence. For example, Dean and Ebrahim (1986: 63) reported that recently-pierced ears are a common source of tetanus infection among young children. Circumcision performed in hygienic environments also carries the risk of infection.

2.5.2 Feeding practices

Many studies have demonstrated that correct feeding practices are fundamental to child health (see, for example, Correa, 1975; Kielmann, Ajello and Kielmann, 1982; Popkin and Lim-Ybanez, 1982; Victora et al., 1984). The optimum child diet consists of a period of exclusive breastfeeding followed by the consumption of sufficient amounts of appropriate and nutritious food. Breastmilk alone provides sufficient nutrients for the average baby to double its birthweight by the age of four months (Ebrahim, 1983:54). The World Health Organisation recommends that infant diets should consist entirely of breastmilk for the first four to six months of life (Akre, 1989: 55). After that, supplementary food should be included gradually, but breastfeeding should continue, ideally for from one to two years. If the child does not receive colostrum in the first few days of life, or if the mother produces insufficient breastmilk because she is in poor health, or if milk formula is used instead of breastmilk, the infant is at risk of becoming malnourished (Akre, 1989).

Zeitlin (1987: 47) notes that there are at least seven immune-defence mechanisms provided or activated by breastfeeding, that the nutrient composition and digestibility of breastmilk is superior to that of substitutes, that it promotes neurological development and long-term cardio-vascular health, and the bond breastfeeding creates between mother and infant contributes to mental health and development. Ebrahim (1983: 55-57) lists eleven essential amino acids which are present in breastmilk but either absent or in different quantities in cows' milk, which forms the basis of most infant formulas. Moreover, the proportions of fats and fatty acids in cows' milk differ markedly from those in human breastmilk and are much less suited to infant nutrition (Ebrahim, 1983: 59-61).

Breastfeeding also has advantages for the mother as well as the child. The uterine contractions induced by breastfeeding assist uterine involution after pregnancy (Akre, 1989: 22). Breastfeeding also prolongs the period of postpartum infecundity and promotes longer birth intervals in populations not using contraception (van Ginneken, 1978; Popkin et al., 1986).

Yet despite these advantages, artificial feeding has become popular in many countries, particularly in urban areas. Although infant feeding bottles have been dated as early as 4000 B.C., prior to the advent of infant formulas the only viable alternative to mother's milk was the milk of a wet nurse (Short, 1992: 33). Short (1992) documents a dramatic reduction in the mortality of foundlings in eighteenth-century Europe from almost 100 per cent in institutions which fed with paps and gruels to 56 per cent where infants were fed by 'wet nurses' (Short, 1992: 33). However, the development in the twentieth century of more digestible and nutritious infant milk formulas has caused many women, in both developed and developing societies, to reject breastfeeding as old fashioned and/or inconvenient.

One reason is that bottlefeeding has an aura of modern science and bestows 'status' as proof of wealth and participation in the modernization process (Kent, 1981: 5). It also grants women greater freedom to participate in activities outside the home. This has caused bottlefeeding to be regarded by many as a desirable alternative, even where environmental conditions are inadequate to ensure that it can be carried out without impairing the child's health status.

Bottlefeeding is dangerous for several reasons. One of the greatest dangers is that the infant is deprived of the immunological benefits of colostrum and breastmilk. Other dangers are potential contamination from water and bottles, and the tendency of low income mothers to over-dilute formulas in order to save money. Chikusa (1991: 191) found that Botswanan children aged under five months who were not breastfed were almost twelve times as likely to have diarrhoea as their breastfed counterparts. This was largely because of an absence of hygienic preparation of formula and bottles. Some writers argue that the health and survival rate of children fed on correctly constituted formula is comparable with that of breastfed children when environmental conditions and standards of preparation hygiene are good, and after the first few months of life they tend to grow bigger and more quickly (Zeitlin, 1987: 50). Even if this is so, it is obvious that safe and correct preparation of formula is seldom possible for the majority of mothers who live in disadvantaged conditions in developing countries.

Numerous studies have shown that breastfeeding is negatively correlated with higher education and mother's employment outside the home, for example, Benefo and Parnell's (1991) study of infant feeding practices in Ghana and Mier y Teran's (1991) study of feeding patterns and children's health in Mexico. On the other hand, other studies have shown that higher incomes and living standards, greater use of health facilities and longer birth intervals of working and educated women apparently offset the deleterious effect of short breastfeeding durations, and increase the survival probabilities of their children (see, for example, DaVanzo, 1984). However, the poverty of the majority of women in the developing world and the absence of optimum conditions for formula preparation means that, in practice, bottlefeeding is associated with a deleterious effect on child health.

Sharma and Rutstein's (1991) analysis of DHS data for 10 sub-Saharan African countries found that, on average, 91 per cent of children were breastfed at six months of age, and 89 per cent still breastfed at twelve months (Sharma and Rutstein, 1991: 405). However, they noted that exclusive breastfeeding in the first four months, as recommended by WHO, was surprisingly uncommon. Except in Burundi and Uganda, where more than half the children surveyed were exclusively breastfed, the average was only 27 per cent. The main supplement reported was water, which could be subject to much the same contamination with pathogens as infant milk formula.

Bankole and Olaleye (1991) found that lack of breastfeeding was not a significant predictor of infant mortality in Kenya, but there was a significant positive relationship between age of introduction of artificial feeding and infant and child mortality. Although these results might seem unexpected, they are consistent with the African pattern of widespread and prolonged breastfeeding. Educated and privileged mothers are those most likely not to breastfeed or to supplement early, while disadvantaged mothers are those most likely to supplement at later ages.

The prolonging of exclusive breastfeeding beyond age six months is usually associated with poverty and can lead to severe malnutrition of infants. Luwang (1985: 618) considered that prolonged, exclusive breastfeeding and delayed weaning are among the most important factors contributing to the high prevalence of malnutrition in developing countries. The association of prolonged breastfeeding and poor growth attainment also was noted by Victora et al. (1984) in their study of Southern Brazil. They suggested that this could be due to mothers producing low-fat milk, inadequate supplementation or suppression of the child's appetite. Brakohiapa et al. (1988) found that protein and energy intakes of Ghanaian children who were breastfed beyond the age of 19 months were about half those of weaned children, because breastfeeding adversely affected children's acceptance of food. They recommended that children aged 12 months or more who are not eating well should be weaned from the breast entirely in order to stimulate their intake of other foods (Brakohiapa et al., 1988: 417).

After children are partially weaned a variety of factors could cause them to receive inadequate intakes of nutritious food. These include behavioural factors, and low incomes or external factors, such as crop failure and famines, which limit the absolute amount of food available and may manifest as high prices. Tabatabai (1989) found a positive relationship between the consumer price index for food and the prevalence of underweight children a few months later in Ghana, Togo, Botswana and Madagascar. Teklu, von Braun and Zaki (1991) found a similar pattern of lagged correlation in Sudan. Interestingly, Tabatabai's study found the reverse pattern in Burundi. Since Burundi is more strongly subsistence-based than the four other African countries in Tabatabai's study, he suggests that the increase in prices may have provided an incentive to increase subsistence food production.

Another cause of poor nutrition in weanlings may be family size and selection within the family, which affects competition for food and may cause some members to be better nourished than others. Desai (1992: 3) reviewed a number of studies of the relationship of family size and child welfare which reached different conclusions. In her analysis of DHS data from 16 countries, 12 showed that the presence of an additional sibling under age five had a significant negative correlation with height-for-age. However, as shown in subsequent chapters of this study, there is considerable difference between the effect on growth attainment of a family comprising several children in the same age group who compete for food, and that of a large, well-spaced family which brings additional income, additional carers and improved food availability.

Lloyd and Gage-Brandon's study of Ghana (1992) showed that, when resources are scarce, large family size may foster sex discrimination in feeding, particularly against female children. However, as discussed above, others such as Ewbank, Henin and Kekovole (1986) and Gbenyon and Locoh (1992) concluded that sex discrimination is uncommon in African countries, although there are many reports of sex discrimination in feeding in South Asian countries (see, for example, Ware, 1984; Das Gupta, 1987; and Basu, 1989a).

As well as quantity of food, frequency of feeding is important for weanlings. Young children have small stomachs and usually cannot consume sufficient foods if subjected to the adult pattern of two or three meals a day. They need to be fed frequently to ensure adequate food consumption. Infrequent feeding has been identified as a cause of weanling malnutrition in several Pacific countries where nutritious foods are abundant, including Fiji (Lucas, 1978) and the Republic of the Marshall Islands (Republic of the Marshall Islands, 1991).

In some societies the child's own behaviour may affect the amount of food it receives. For example, Hamilton (1981: 52) reported that among the Gidjingali Aborigines of Australia's North-East Arnhem Land, the accepted practice is to give children only the care they demand. Small children learn to take the breast if they wish to suckle and older children are not given food unless they ask for it. Active and demanding children receive more food. This probably applies to some extent in large families in any society, where children must compete for attention and care. Children who are less assertive are at risk of becoming malnourished. However, Bledsoe (1990) reported that the ability of some West African children to 'scrounge' and steal food may offset the disadvantage of being fostered, which normally leads to inferior nutrition.

The process of weaning itself, especially if it occurs early, may be a stressful event which increases a child's susceptibility to infection. Ebrahim (1983: 86) reported that it is common in some communities in Uganda to send children away to live with their grandparents for a few months when their mother wishes to wean them. This adds the unhappiness of separation to the nutritional stress caused by the sudden change from a high-grade to a low-grade food.

Child health is affected not only by the direct impact of poor nutrition, but also by nutrition of mothers during pregnancy and while breastfeeding. High-protein foods promote good foetal development, while protein, calorie and micro-nutrient deficiencies lead to poorly developed and low birthweight babies. Many studies have shown that low birthweight babies have a higher mortality rate (see, for example, Saugstad, 1981; Srivastava and Saksena, 1981; McCormick, 1985; Miller, Goldman and Moreno, 1991). Mundel (1980) found a close association between low birthweight and moderately retarded intellectual development.

Herrera (1987: 80) considered that maternal size before and during pregnancy is a key factor in determining birthweight, and cited several studies which have shown a positive correlation between maternal height, weight, weight-for-height and infant birthweights. Bantje (1986) demonstrated a strong correlation between maternal weight and birthweight in a sample of Tanzanian mothers. Poorly nourished mothers tend to produce low birthweight babies, either as a direct result of their inferior nutritional status or as a result of their increased susceptibility to infection (Papiernak, Frydman and Spira, 1980).

As well as increasing the likelihood of low birthweight, poor maternal nutritional status may increase the risk of perinatal mortality. Kwofie, Brew-Graves and Adika (1983) found maternal malnutrition was widespread in Zambia, and contributed not only to low birthweight and congenital malformations, but also to high levels of maternal mortality and especially perinatal mortality and morbidity. In Indonesia, Sanie and Surjadi (1987: 14) regarded a maternal weight of less than 40 kg as an indicator of a high-risk pregnancy. In a Guatemala nutrition intervention programme Habicht et al. (1974a) found that maternal nutrition had a crucial role in increasing birthweight and reducing infant mortality, while Klein et al. (1979) emphasized the positive effect of good maternal nutrition on birthweight and subsequent child development.

The nutritional status of the mother also has an impact on her ability to breastfeed. Wray (1978: 198) concluded that in populations where the effects of maternal diet on lactation are likely to be important, the mothers have often been malnourished all their lives. He referred to an Egyptian study which found that lactose and fat content were slightly lower and protein significantly lower in milk from malnourished women compared with that from well-nourished women. Idusogie (1975) reported that poorly nourished mothers may produce not only less but also inferior quality breastmilk, deficient in vitamin A and thiamin. However, Jelliffe and Jelliffe (1978) argued that this is true only in cases of extreme maternal malnutrition.

While nutritional status affects ability to breastfeed, the act of breastfeeding itself affects the nutritional status of lactating mothers. Miller, Rodriguez and Pebley (1993: 586) found that both full and partial breastfeeding were associated with a weight loss of approximately 235 gms per month among lactating Bangladeshi mothers, compared with mothers who were not breastfeeding. More rapid weight loss among those with higher parities presumably reflects the cumulative depleting effect of many pregnancies. On the other hand, an overall pattern of weight gain was reported for women who were not breastfeeding, most of whom had recently weaned children (Miller, Rodriguez and Pebley, 1993: 584). Thus short birth intervals are likely to increase the probability of the mother having poor nutritional status and impaired lactation performance.

It thus can be seen that both child-feeding practices and maternal nutrition have a critical relationship with child survival and growth attainment. Moreover, they are determined by socio-economic, demographic and environmental factors, including education, control over resources, maternal depletion and food availability. The nature of the relationship of growth attainment with morbidity and mortality is discussed in more detail in Chapter Five.

2.5.3 Immunization and Oral Rehydration Therapy

Another important aspect of child care behaviour, and a crucial part of health service utilization, is immunization. Immunizing infants against major infectious diseases is one of the most important focuses of health programmes throughout the world, in both developed and developing societies, and has had a major impact on child survival. In areas where environmental sanitation is poor, or where traditional birth attendants use unclean instruments to cut the umbilical cord, the child may not survive its first encounter with the world without immunization.

Henderson (1984a: 3) identified the main preventable childhood diseases as measles, pertussis, tetanus, poliomyelitis, diphtheria and tuberculosis. He estimated that these diseases kill an average of five million children per year and cripple, mentally retard or blind an equal number who survive attacks. The target groups for immunization against these diseases are infants in the first year of life and women who are pregnant or expecting to bear children.

In most cases immunization is extremely effective in preventing disease. Nonetheless, the reliability of the product is no guarantee of universal availability of properly stored vaccine or its acceptability. Henderson, (1984a: 10) concluded that the macro-level reasons why deaths continue to be caused by immunization-preventable diseases are lack of political will to provide the necessary financial and human resources, and lack of management skills to administer the programmes. At the micro level a number of believed and perceived side effects may discourage mothers from obtaining immunizations for their children.

First, although WHO estimated that children can be fully immunized for from US $ 5.00 - 15.00 per child, (Henderson, 1984a: 10) and that this could be financed for an annual outlay of less than US $ 1.00 for every individual in the developed world, the funds to carry out this programme in its totality have not been made available. As a consequence immunizations must be purchased in some countries. Even though the cost is usually small, this may act as a deterrent to very poor mothers, especially if they need to ask their husbands to pay.

Second, immunizations may have side effects. If injected they usually have the immediate effect of causing the child to cry. Later they may bring fever or some form of mild illness. There is almost always some degree of inflammation and soreness at the site of vaccinations. Heggenhougen and Clements (1987: 17) noted that such adverse effects may discourage completion of courses of vaccine, which is an important problem that needs to be addressed through education. They also cited Ford (1984) who mentioned more serious consequences, for example, the association of pertussis immunization with a high level of allergic disease. DPT vaccine can produce shock, convulsions and sometimes Reyes syndrome, which can make children liable to develop severe, permanent brain damage (Miller, Alderslade and Ross, 1982: 16-17). The British National Childhood Encephalopathy Study of the 1970s found the that relative risk of children developing neurological illness within 72 hours of DPT immunization was 4.2 times that for non-immunised children.

Although new formulations have been developed which lead to fewer complications, they are not yet widely available, and if clients have seen or heard about severe reactions in the past, they may be more afraid of the side effects than of the immunizable disease (Heggenhougen and Clements, 1987: 17-18). In Uganda the writer was informed by medical staff that a temporary switch to a stronger strain of BCG vaccine which caused enlarged lymph glands, had substantially reduced attendance at immunization clinics (Dr L. Kapiriri, personal communication).

Third, immunization may not be available at a convenient or close location. There may be time and travel expenses involved in taking the child to obtain the immunization. Henderson (1984a: 11) reported that scarcities of administrative resources to dispense vaccines sometimes caused donated supplies to spoil before they could be dispensed. Heggenhougen and Clements (1987: 18) referred to a 1972 study in Cameroon which found that only 40 per cent of sero-negative children developed antibodies after being given measles vaccine. In orthodox Muslim areas it may be necessary for teams to visit each house to dispense immunizations to women and children confined to their homes by their religious practices (Henderson, 1984: 76). There is also the question of the timing of the offering of immunization services and, indeed, any other health services. If they are available only at times when women are working in the fields they are unlikely to be widely utilized (Henderson, 1984: 77)

Fourth, some immunizations are not effective unless repeated doses are given. Stoeckel (1984: 119) found that in West Africa a 20 per cent dropout rate between one dose and the next was usual. If the side effects were marked, the travel difficult, the waiting time long or the mother misinformed, she tended not to bother to take the child back for the full course of treatment. Alternatively, mothers may impair the effectiveness of immunization by not observing the correct intervals between doses.

Fifth, depending on the communal belief as to the cause of illness, immunization may not be regarded as important or even useful by mothers (Heggenhougen and Clements, 1987: 22). In some cases mothers may receive conflicting advice from other village women and health experts. This may cause confusion and uncertainty about correct procedures, and cause women to resist immunizing their child, either because they lack confidence in the utility of the process, or because they are reluctant to go against the advice of other women in their community (Henderson, 1984a). It is probable that mothers who receive immunization themselves during the antenatal period subsequently will be less resistant to programmes to immunize their infants.

Finally, immunizations are not available for all diseases. Although progress has been made with vaccines for streptococcus pneumonia and rotavirus, they are not yet in commercial production (Phillips, Feachem and Mills, 1987: 15). Also, mutations of viruses for which vaccines exist, especially influenza, may result in new strains appearing from time to time, and a time lag before vaccines are available.

Even if efforts such as correct feeding and immunization fail to prevent a child from contracting an illness, correct treatment of illness can reduce its severity, duration and the risk of mortality. Hirschhorn (1987: 21) quoted *The Lancet* editorial which hailed Oral Rehydration Therapy (ORT) for diarrhoeal disease 'as potentially the most important medical advance this century'. He estimated that ORT can be expected to be an effective treatment for the 82 per cent of diarrhoea episodes that are considered to be capable of causing dehydration, and that the need for hospitalisation can be reduced to 2 per cent of cases or less.

ORT treatment has massively reduced child mortality from diarrhoeal disease by up to 50 per cent throughout much of the developing world (Hirschhorn, 1987: 22). It acts by maintaining the critical level of fluids and the electrolytic balance during illness, thereby preventing lethal or damaging dehydration. In addition it prevents nausea and allows normal food intake to be maintained, therefore minimizing weight loss during diarrhoea episodes (Hirschhorn, 1987: 26). Thus, since malnutrition appears to prolong the duration of episodes of diarrhoea (Black, Brown and Becker, 1984: 92), an indirect effect of ORT could be to limit the duration of subsequent bouts by facilitating food intake and minimizing weight loss. It may also help to protect the jejunal (small intestine) absorptive enzymes, which are normally destroyed by fasting, thus maintaining the ability to absorb and utilize food intakes (Hirschhorn, 1987: 34).

Although the treatment is simple and cheap, it relies on mothers being well informed as to the effectiveness of ORT and the method of application. Wong and Agarwal (1993: 90) reported that in their Tunisian study educated mothers were more likely to treat children for diarrhoea, but more education did not increase the likelihood of seeking medical treatment. The effect of having a general health service, such as a dispensary, in the vicinity had the same effect. However, this would seem to be a reflection of the success of home treatments for diarrhoea, and analysis of the care given for other childhood diseases might have resulted in a different pattern.

On the other hand, correct knowledge about the cause of disease may not be essential. Dattal et al. (1988) found that more than 47 per cent of a 1981 sample of Indian women from Himachal Pradesh believed that marasmus was due to Evil Eye or shadow, and did not recognise its association with chronic diarrhoea. Surprisingly, this belief was more prevalent among urban women than among rural women, while the majority of both groups believed that illness should be treated with restricted diets based on a classification of food as 'hot' or 'cold'. However, in a different Indian study, Kumar, Kumar and Raina (1989) reported that although there was no change in traditional beliefs about the causes of diarrhoea, users of ORT increased from 20 per cent to 73 per cent after experiencing two years of promotion by a health worker.

Treatment of conditions such as diarrhoea also depends on whether the mother recognises a need for treatment (de Zoysa et al., 1984). Some mothers may regard mild diarrhoea as a normal condition, while uninformed mothers may be deterred from using ORT because it does not stop the diarrhoea and gives the child more fluids to pass. This could be interpreted as a worsening of the condition. It also is important that mothers prepare the solution correctly, using boiled water and the correct amount of salts, otherwise giving ORT could inhibit the effect of the treatment, exacerbate the illness, or transmit another disease to the child. This can lead to bad publicity for the treatment. Hirschhorn (1987: 41) also noted another source of bad publicity for ORT. In some areas opposition to family planning is apparently so great that the concurrent promotion of ORT and contraceptives has led to the belief that ORT is a baby killer.

Other major causes of child death are fever and respiratory disease. Severe episodes of these diseases are less likely to be treated successfully in the home than episodes of diarrhoea; so the chances of a child receiving insufficient care are greater. Mothers need to learn to judge the severity of these diseases, and to know when over-the-counter preparations are sufficient and when medical assistance should be sought. Successful treatment of these diseases may depend upon access to appropriate medication. As discussed above, Streatfield, Tampubolon and Surjadi (1990) found that even when knowledge of the optimum treatment was present, costs often caused Indonesian mothers to try cheaper street medicines in the first instance. Castle (1993: 158) concluded that in extended family households in Mali, the social position of women in relation to each other was a more important determinant of child-illness management than their position in relation to men. Head wives and those obligated to a mother-in-law within the household were more likely to obtain appropriate treatment for their children's illnesses than lone wives, female heads and women living in their natal families.

2.6 DISCUSSION

Much of the preceding discussion can be summed up by Winikoff's (1988: 1) observation that there is an inter-generational transfer of ill health from mothers to daughters, via 'a complex interplay of social, economic, cultural and biological factors'. A mother with poor health lacks the energy and resources to care for her children properly. The female children of such mothers are likely to receive poor health care, poor nutrition and little education. They are likely to grow up burdened with conditions such as internal parasites, anaemia, malaria and malnutrition, and when they have children of their own they, in turn, are likely to lack the energy and resources to care for them properly. Winikoff considered that this cycle can theoretically be broken at any point, and the more places it is attacked the more the chances of preventing ill health from passing between generations.

The literature reviewed above lends support to the view expressed in Chapter One that it can be difficult to determine which of several interacting factors is underlying. It is apparent that factors from one group rarely act completely independently of factors in other groups and that some can exert their influence in various ways. This complexity points to the importance of treating groupings of factors as broad categories for convenience only, and of considering interactions, rather than basing judgements on bi-variate analysis.

It also is apparent that the interplay between different groups of factors affects both survival and growth attainment in similar ways. Although poor growth attainment is a precursor to death in only a minority of cases, both outcomes tend to be the product of similar socio-economic, environmental, demographic and child care patterns. Detailed analysis is thus required to identify particular combinations which determine whether a child will survive or die. The present study uses multi-variate techniques to compare similarities and differences in the patterns of association of various factors with mortality and growth attainment, with a view to identifying special circumstances which increase the risk of mortality.

In order to interpret this analysis it is necessary to have some understanding of the countries from which the data are drawn, and the nature of the data. The first part of Chapter Three thus comprises a brief overview of the characteristics and history of the three study countries. The second part describes the data sets and considers their limitations.

CHAPTER THREE: THE GEOGRAPHICAL SETTING, DATA SOURCES AND DATA LIMITATIONS

3.1 INTRODUCTION

Burundi, Uganda and Zimbabwe are three land-locked countries situated in East and Central Africa. Each experienced occupation by European colonial powers, and each has suffered periods of violent conflict within the last two decades. Despite these common features and their geographical proximity, the three countries are distinctly different in many ways. They exhibit a range of land types, vegetation and climatic conditions, and at the time of DHS surveys there were marked variations in their economic and social conditions. The people, too, are heterogeneous, with Burundi and Zimbabwe each having two major ethnic groups, while Uganda has more than ten. Table 3.1 presents recent UNICEF estimates of several demographic and economic indicators for the three countries.

Table 3.1: BASIC INDICATORS, 1991: BURUNDI, UGANDA AND ZIMBABWE

Country	Population (million) (1)	Census year	GNP (2)	TFR (3)	Eo (4)	IMR (5)
Burundi	5.3	1990	210	6.8	52	108
Uganda	16.6	1991	220	7.3	43	110
Zimbabwe	10.4	1992	640	5.5	56	61

NOTES:
(1) latest available census figure
(2) US $ per capita, from UNICEF, 1993
(3) Total fertility rate, from UNICEF, 1993
(4) Life expectancy at birth, from UNICEF, 1993
(5) Infant mortality rate, from UNICEF, 1993

Although it can be seen that Zimbabwe is substantially better off in terms of GNP, fertility and mortality, all three countries must be considered relatively poor by world standards. Sierra Leone was the only country estimated by UNICEF (1993) to have a lower life expectancy at birth than Uganda, while even in Zimbabwe life expectancies are low compared with much of the developing world. The infant mortality estimates for Burundi and Uganda are high, although not among the highest in the world, while that for Zimbabwe is approximately the same as that of its wealthier neighbour, Botswana. The estimated total fertility rate for Uganda is among the highest in the world, and that for Burundi also very high. Zimbabwe fertility has declined in recent years and is now moderate compared with most of the African continent, but nonetheless substantial by world standards.

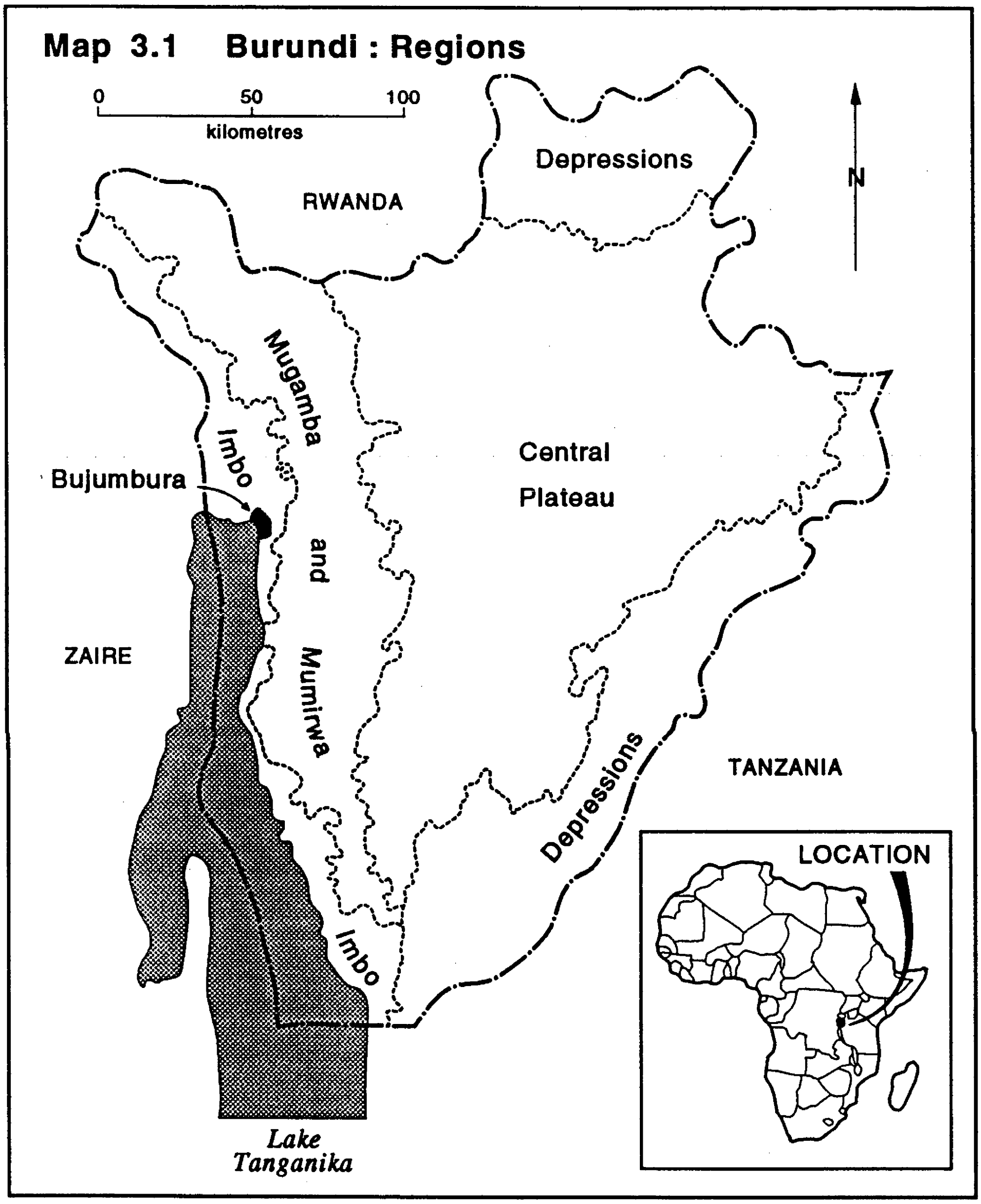
The following sections outline the physical characteristics, recent history, economic and social setting and health and nutrition situation in the three countries in order to provide a background against which to view the analysis in Chapters Four, Five, Six and Seven.. Particular attention is paid to recent history, without which it would be difficult to understand the prevailing socio-economic conditions. Subsequent chapters demonstrate that physical, historical, economic and social differences between the three countries have a direct bearing on child health and survival.

3.2 BURUNDI

3.2.1 Physical features

Burundi is the smallest of the three countries. It is situated on the eastern shores of Lake Tanganyika, and shares borders with Zaire, Rwanda and Tanzania (Map 3.1). Much of the terrain is very mountainous, and Burundi is sometimes promoted as the 'African Switzerland' (Republique du Burundi, 1990: 5). The total land area is 27,834 square kilometres (Nkurunziza, 1991:10), which is a little over one-tenth the area of Uganda and less than one-twelfth of the area of Zimbabwe. Lake Tanganyika, which covers an area greater than the territory of Burundi, is very deep, and provides a substantial aquatic environment, including rich fishing grounds and wetland habitats. It is one of only a few inland lakes in the world to support coconut palms (Crowther, 1989: 148).

Nkurunziza (1991:10) classified the land into four natural regions. Imbo Province, to the extreme west, is a narrow, fertile flood plain, immediately adjacent to the lake, averaging 800 to 1000 metres above sea level. To the east of Imbo the towering mountain escarpments of la Chaine de la Kibira rise sharply to altitudes in excess of two thousand metres, their steep slopes blanketed by thick forests. The mountain provinces of Mugamba and Mumirwa occupy some of the most rugged terrain. Further eastward the mountains give way to the hills of the Central Plateau, with altitudes of 1500 to 2000 metres. The fourth region comprises the valleys of the Depressions to the north-east and on the eastern border, with average altitudes of 1200-1500 metres.



Map 3.1 Burundi : Regions
0
50
100
kilometres
N
RWANDA
Depressions
Mugamba
Imbo
Bujumbura
and
Central
Plateau
ZAIRE
Mumirwa
TANZANIA
Depressions
Imbo
LOCATION
Lake
Tanganika

Although the whole country is situated just a few degrees south of the equator, variations in relief lead to distinct climatic differences between regions. The plains of Imbo are relatively hot and dry, with average temperatures around 20-23^{o} C and an average annual rainfall of 800-1000 mm (Nkurunziza, 1991: 11). Lake Tanganyika moderates the equatorial climate with on-shore breezes, but at the same time has a negative effect on health by assisting the transmission of water-borne diseases, and providing a breeding ground for mosquitos.

Temperatures average less than 15^{o} C and annual rainfall more than 2000 mm in the mountains, while climates are relatively temperate in the plateau and valley areas, ranging from 17-20^{o} C with 1200-1500 mm rainfalls. The whole country is also subject to seasonal variations, with a major dry season from June to October and a major wet season from March to May (Barandereka and Berciu, 1981:53). Nkurunziza (1991: 11) observed that, although rainfall is irregular and the climate sometimes capricious, the Burundais climate is the envy of the drier lands of the Sahel.

3.2.2 History and development

The original inhabitants of Burundi were the pygmy mountain people, the Twa (or Tua). Migrations of the Bantu Hutu people over the last 1000 years, and of the Nilo-Hamitic Tutsi in the last 400 years, have reduced the Twa to around 1 per cent of the total population, confined to the most inaccessible mountain areas. The primarily agriculturalist Hutu now comprise some 85 per cent of the total population, while the remainder are the Tutsi, who were traditionally pastoralists (Hiernaux, 1974: 60; Phillips, 1989: 10).

The Tutsi soon dominated the Hutu, establishing a feudal system in which the Hutu performed services in return for cattle and protection by Tutsi lords. At the time of the first European occupation in the late 1880s Burundi was ruled by a dynasty of Tutsi kings (Republique du Burundi, 1990: 10). Its inland location protected it from the incursions of the slave trade, but not European colonialism. At the Berlin Conference of 1884-85, where Africa was shared out among the colonial powers, Burundi (then called Urundi) and Rwanda were allocated to Germany. Germany was subsequently ousted by Belgium during World War I, and both Burundi and Rwanda were mandated to Belgium by the League of Nations in 1918 (Republique du Burundi, 1990: 10-11).

The Belgians utilized the existing political structure to govern the country, and bestowed considerable advantage on the Tutsi feudal lords, empowering them to recruit labour and to raise taxes from the Hutu (Crowther, 1989: 141). The Tutsi, but not the Hutu, also received some theological and educational training from Belgian Catholic missionaries. Following the introduction of *arabica* and *robusta* coffee varieties in the early 1900s the Belgian administration promoted the intensification of coffee culture (Delor-Vandueren and Degand, 1992: 32). Again, the Tutsi were the only indigenous group to benefit from this colonial initiative (Crowther, 1989: 141).

The growing political, social and economic disparity between the two groups inevitably generated dissatisfaction among the Hutu majority. In 1958 Prince Rwagasore, a Tutsi, attempted to stem the rising opposition of the Hutu by founding le Parti de L'Unité et du Progrés National, which focused on achieving independence for the nation, and played down ethnic differences (Republique du Burundi, 1990: 13). However, he was assassinated in 1961, only two weeks after winning the elections (Galaty and Bonté, 1991: 287). The assassination was allegedly supported by the Belgian colonists, who feared they would lose commercial power in a united Burundi (Crowther, 1989: 141). Despite this, Burundi was granted independence on 1 July 1962, with political power still in the hands of a Tutsi monarch, King Mwame Ntare V (Republique du Burundi, 1990: 13; Phillips, 1989: 10).

The Hutu were unable to gain representation in government, even after winning the majority of seats in the 1964 election. Moreover, the Tutsi monarchy itself was unstable. The king was deposed by his son, Crown Prince Ndizeye, in 1966. Later that year Prince Ndizeye was ousted by his own Prime Minister, Captain Michel Micombero, who abolished the monarchy and proclaimed Burundi a republic (Republique du Burundi, 1990: 13, Phillips, 1989: 10).

President Micombero's ten year rule was marked by the eruption of major conflict between the Hutu and Tutsi in 1972, and the systematic elimination of Hutu elite from all professional, commercial and military jobs, involving the death of an estimated 50,000-100,000 (Galaty and Bonté, 1991: 287). Since then major ethnic conflicts have continued intermittently. The ousting of President Micombero by Colonel Jean-Baptiste Bageze[1] in a coup of 1976 led to a brief period of relative stability (Galaty and Bonté, 1991: 287). However, this ended when President Bageze was, in turn, overthrown by Army Major Pierre Buyoya in September 1987, and instability has continued since then (Phillips, 1989: 10). A Hutu victory in the 1993 election was followed by the assassination of both the elected president and his successor.

1 Colonel Bageze is referred to as Colonel Bagaza in Phillips (1989: 11).

As a result of the sustained instability, many refugees fled to Tanzania, Uganda and Rwanda, and large areas of Burundi appear to have had their populations substantially reduced (Phillips, 1989: 11). The conflict between Hutu and Tutsi is not confined to Burundi. The stage for confrontation shifts to neighbouring Rwanda from time to time, where there is a similar ethnic mix, but where Hutus have dominated government. Hutu fighting forces use Rwanda as a base, while Rwanda-born Tutsis cross the border to fight with Burundais Tutsis (Jean-Bosco, personal communication). In April 1994 the simultaneous assassination of the Hutu presidents of both countries, the Tutsi rebellion in Rwanda, and the subsequent massive slaughter of both ethnic groups attracted world attention.

Although the on-going conflict has disrupted economic activity to some extent, Burundi has a well-established agricultural sector. The 1979 census reported 93 per cent of the population engaged in primary industry, most in subsistence cultivation of crops which include cassava, bananas, sweet potatoes, beans and other pulses, maize, sorghum and vegetables (Republique du Burundi, 1990: 16). Cattle herding and fishing are also important subsistence activities. Surpluses from subsistence activities are sold at local markets. Burundi also has well-established coffee, tea, oil palm and sugar plantations, with coffee accounting for some 80 per cent of national exports (Delor-Vandueren and Degand, 1992: 32). A small manufacturing sector produces cotton fabric, beer and plastics (Republique du Burundi, 1990: 16). There has also been investment in tourism (Republique du Burundi, 1990: 19), but, given the on-going political instability, it is hardly surprising that this sector is not yet well patronised, despite considerable potential.

The DHS survey of 1987 occurred during a relatively stable period in Burundi's history, just prior to the ousting of President Bageze by Army Major Pierre Buyoya. The five years preceding the Enquête Demographique et du Santé du Burundi (EDSB), to which much of the child data analysed in this study relate, were also comparatively peaceful. This period saw increasing government involvement in population issues. The results of the 1979 census drew attention to the rapid population growth rate and caused concern, particularly in regard to the balance between population and food production (Nkurunziza, 1991: 21). In 1983 family-based strategies to reduce fertility included the introduction of a later legal age at marriage and restrictions on polygamy (BMI & IRD, 1988: 4).

3.2.3 Population and settlement

The volcanic highlands of Burundi and neighbouring Rwanda are among the most densely populated regions in Africa (Grove, 1989: 131). In the early 1920s the Belgian administration judged the population of Burundi to be 'very dense....with an abundance of manpower' (Nyambariza, 1990: 101). It is not clear why official estimates of the total population declined from three million in 1924 to less than two million in 1930, and whether this was a genuine decrease or an artifact of differing methods of estimation. However, on the basis of parish records, Feltz (1990: 123) reported 'a brutal decrease' in population in 1937-38, when there was a typhus epidemic, and in 1947-48, which was not explained. Major, although possibly localised, famines are reported for 1889-1890, 1904-1911, 1915-1916, 1922-26 and 1943-44 (Feltz, 1990: 125). Although there was no complete census until the 1970s (Feltz, 1990: 113), there appears to have been steady growth since the late 1940s (Nyambariza, 1990: 106).

The 1979 census reported a total population of 4,144,135, with an average annual growth rate of 2.6 per cent (Nkurunziza, 1991: 12). The low sex ratio of 93 males per hundred females can be attributed to mortality in warfare (BMI & IRD, 1988: 4). By 1988 the total population was estimated to have increased to 5,068,788, with a growth rate of 2.9 per cent in the intercensal period (Service National des Etudes et Statistiques (SNES), 1988: 52). The total fertility rate (TFR) was estimated as 6.5 in 1982, 6.4 in 1985 and 6.5 in 1986 (Nkurunziza, 1991: 14). The estimate for 1987, based on EDSB, was 6.8 (BMI & IRD, 1988: 28). In 1988 the average population density of Burundi as a whole was said to be a very high 182 persons per square kilometre (SNES, 1988: 52).

The population growth rate must be considered remarkable in view of the massive mortality from civil strife. Population growth has been possible because fighting has generally been confined to certain areas, and much of the population has not been severely affected. The relative lack of disruption may be attributed to the traditional settlement pattern, which is based on individual family clusters rather than villages and towns. Villages are unknown in Burundi, and settlement is generally scattered except in a few residential areas of the towns (Barandereka and Berciu, 1981: 53). Groups comprising a family head, his or her direct descendants and parents live near their land in *rugos*. These are clusters of several huts, usually constructed of mud with grass roofs, surrounded by a hedge or fence (see Plate One). Individual brick or clay houses have replaced *rugos* in more densely populated areas.

PLATE ONE: A *rugo* and householder with water carrier.

UNICEF (1988: 7) reports that in 1986 25 per cent of rural households and 21 per cent of urban households were headed by women. This high proportion must be attributed in part to the effects of civil conflict, and perhaps also to the growing impact of acquired immuno-deficiency syndrome (AIDS), since women generally occupy a subordinate position to males in Burundais society and are not encouraged to be independent. The Belgian colonial regime reinforced the subordinate position of women. Hunt (1990) describes a major special education programme for urban women in the period after the Second World War, which emphasized domestic training in house management skills in order to enforce gender roles and to instil Western family ideology into urban African life. Present day Burundais women are disadvantaged in terms of access to education, employment and finance (UNICEF, 1988: 7). Average income in female headed households in Buyenzi township, Bujumbura, was only 60 per cent of the male average in 1986. However, there were fewer malnourished children in households headed by women (UNICEF, 1988: 7).

Only an estimated 5 per cent of Burundi's population is urban, with only two urban areas of any note, Bujumbura in Imbo Province and Gitega on the Central Plateau (UNICEF, 1993: 76). In 1991 the writer found the capital, Bujumbura, to be little more than a village adorned by a modern airport and a handful of luxury hotels. Although the urban centre is set out formally, with wide tree-lined boulevards named after important historical figures and events, most of the streets were unpaved. There was only a little modern commercial activity, with the larger shops and hotels operated by expatriate Europeans. Although some housing was of good quality and benefited from modern services, conditions in the township quarters were overcrowded and squalid.

3.2.4 Health and nutrition

UNICEF (1988: 7) comments that health and education initiatives in Burundi are 'numerous but uncoordinated'. The country is served by a network of some 250 health facilities, including hospitals, health centres and clinics, but only two-thirds of these are considered to have an adequate water supply and there is a shortage of health personnel (UNICEF, 1988: 7). Sixty per cent of the population lives within 5 kilometres of a clinic or health centre, and 74 per cent within six kilometres (UNICEF, 1988: 6). FAO (1987b: 9) reports that in 1983 only 22 per cent of the rural population had access to a safe water supply, despite the initiation in 1978 of a vigorous programme of capping spring-water sources. This compares with 77 per cent of urban dwellers in 1972.

Ninety-six per cent of urban dwellers had access to safe toilet facilities in 1972, but this figure had declined to only 50 per cent by 1983, compared to 52 per cent of rural dwellers in that year.

Burundi has adopted a programme of primary health care. O'Toole (1989) commented that the Government of Burundi is determined to orient health services towards social medicine. Health committees, formed at the grassroots level, involved local political groups to ensure public participation (O'Toole, 1989: 19). The WHO Expanded Programme of Immunization was introduced in 1982, and 55 per cent of children were estimated to be fully immunized by December 1987 (UNICEF, 1988: 7). DHS found that 46.5 per cent of surveyed children had a health card[1], and, of these, 46.2 per cent were fully immunised (BMI & IRD, 1988: 71). Less progress had been made in the introduction of ORT by that date. Although health centres knew of it, it was not widely used. The existing, but limited, family planning and maternal and child health programmes received increased UNFPA funding in 1982, with an emphasis on the integration of services. A major constraint on the wider implementation of primary health care was the limited nature of health education programmes (UNICEF, 1988: 9).

FAO (1987a: 7) lists Burundi as a country where the supply of available food, measured in average kcal per day increased in the periods 1969-71 and 1979-81, from 2,215 to 2,354. The composition in the later interval was 25.3 per cent from cereals, 35.4 per cent from roots and tubers, 17.6 per cent from pulses and nuts, 2.9 per cent from animal products, 0.8 per cent from sugar, and 18 per cent from other sources (FAO, 1987a: 7). FAO (1987b: 4) reports that Burundais diets are almost exclusively vegetarian. Manioc and palm oil are the staple foods in the lowland areas, while residents of the upland areas more likely to consume substantial quantities of maize, sweet potatoes, beans and green leafy vegetables.

Generally, malnutrition is more prevalent in urban than rural areas. A 1973 study found 31 per cent of children aged 1-5 years in Bujumbura were less than 80 per cent of the reference value for weight-for-age, and 16 per cent less than the reference value for weight-for-height (FAO, 1987b: 6). United Nations (1992: 9) estimates that 31 per cent of Burundais pre-school children are underweight. This is more than in most other African countries with comparable GNP per capita, including Uganda, but less than in

1 The present study will use the term 'health card' to refer to the record card commonly issued by maternal and child health clinics throughout the world. This card, depicted in Figure 5.6, is used as a record of age, birthweight and immunizations received, and also to monitor weight changes over time. Possession of a health card indicates that the child has attended a health facility at some time.

Ethiopia. UNICEF (1988: 6) estimates that in some regions more than 35 per cent of children under age five suffer from serious protein and calorie malnutrition. A 1983 study in Imbo province found both high levels of chronic malnutrition and a high prevalence of severe anaemia among children aged 12-14 months. However, iodine deficiency is comparatively uncommon in Burundi (FAO, 1987b: 6).

3.3 UGANDA

3.3.1 Physical features

Uganda is located on the shores of Africa's largest body of inland water, Lake Victoria, and straddles the equator. It shares borders with Sudan, Kenya, Tanzania, Rwanda and Zaire. Most of Uganda is flat to rolling terrain, averaging 1000 to 1500 metres above sea level, with maximum elevations up to 5000 metres (Langlands, 1975: 1). Eighteen per cent of the territory is open water and swampland, facilitating transmission of water-borne disease and providing breeding grounds for mosquitos (Langlands, 1975: 2). Twelve per cent is forest reserves and national parks (UNICEF, 1989: 5). Soils are generally rich and highly productive. The natural vegetation is lush rainforest in the central wetter areas and grasslands suitable for pastoralism in the drier northern areas.

The equatorial climate is tempered by altitude, with a mean annual range from 17.5^{o} to 33^{o} C. With the exception of Karamoja to the north east, most of Uganda has a reasonably reliable annual rainfall of 1000-1500 mm (Langlands, 1975: 4). Rainfall is usually evenly distributed in the wetter areas of the country. The northern areas, including Karamoja District, may have 4-5 months without rain, but in good years can support crops of millet, sorghum and maize (Biellik and Henderson, 1985: 145). In drought years, however, the semi-nomadic population becomes totally reliant on cattle. Baker (1975: 187) commented that the Karamojong pastoralist traditional system of utilising a marginal physical environment represented 'an extremely delicately adjusted ecological balance in which the threat of destruction was never very distant' . However, during the colonial period pastoralists were confined to specific areas and obliged to adjust to development initiatives, including irrigation systems and the prohibition of burning of pastures. This destroyed the balance and led to problems of overstocking and environmental degradation, which manifest as increasing lawlessness and raiding of neighbouring tribes (Baker, 1975: 191-199).

Most of the country, and particularly the densely settled Buganda area beside Lake Victoria, offers excellent conditions for agriculture or livestock. Fishing is also a major subsistence and trading activity in much of Uganda. Grove (1989: 131) commented that southern Uganda has the potential to be one of the most productive agricultural areas in Africa. In peaceful times it has produced rich crops of coffee and cotton for export, as well as bananas, vegetables and maize for local consumption. During Britain's colonial rule Churchill dubbed Uganda 'The Pearl of Africa' because of its agricultural productivity. However, UNICEF (1989: 5) reported only 5 per cent under cultivation in 1988 compared with 13 per cent in 1958.

3.3.2 History and development

Uganda's inland location protected it from the predations of the slave trade, and the country was virtually isolated from the rest of the world until the arrival of British explorers in the early 19th Century. In 1875 the explorer Stanley reported great potential for spreading Christianity in the country (Griffiths, 1984: 70). This led to an influx of missionaries from various denominations. The subsequent martyring of many early converts during the reign of the Buganda *kabaka* (King) Mwanga led to the establishment of a British colony in 1890, allegedly to afford protection for Christians (Griffiths, 1984: 71).

Hailey (1938: 444) considered that the Buganda kingdom already had 'a developed political organization' when the British arrived, which was utilized by the colonial powers. During the colonial period the British created a centralized administrative system, an agricultural export economy based on coffee and cotton, and sound education and health care systems (Brett, 1992: 12). However, they did not dominate the ownership of agricultural production to the same extent as in other colonies, such as Rhodesia, largely because of the already well-established Baganda feudal system of land holding (Hailey, 1938: 762).

Uganda became independent on 9 October 1962 with a new constitution which preserved the four traditional kingdoms. King Mutesa II, leader of the most powerful kingdom, Baganda, was installed as the first head of state, with Dr Milton Obote as prime minister. However, deep ethnic, cultural and linguistic divisions manifested in tribal rivalries, which led to a series of coups and a period of extreme instability and bloodshed (Griffiths, 1984: 71). In 1966 Dr Obote used the army to establish himself as president and rewrote the constitution to abolish the monarchies. In 1971 President Obote was himself displaced by his own army officer, General Idi Amin Dada.

President Amin drew his main support from the Moslem northern areas of Uganda (Boyd, 1987: 94) and systematically eliminated all opposition to his regime (Griffiths, 1984: 72). He also damaged the economy severely in 1973 by expelling the substantial Asian community, which had dominated urban commerce (Scheyer and Dunlop, 1985: 29), and later by nationalising British companies and dispersing their assets. Although there had been some expansion and upgrading of infrastructure, education and services in the first decade after independence (Brett, 1992: 17), in the period 1973-1982 these systems deteriorated, and real per capita income declined by an average of more than 4 per cent per annum (Griffiths, 1984: 73).

President Amin invaded Tanzania in 1978 because of a border dispute, but despite Libyan reinforcements, his army was overwhelmed when Tanzania retaliated. Ex-President Obote, who had been in exile in Tanzania and whose supporters had joined with Tanzania to oust President Amin, was returned to the presidency by the election of 1980, after a brief period of provisional government. However, by this time inter-tribal conflict and social and economic disruption were widespread (Griffiths, 1984: 73). In 1985 President Obote was, in turn, overthrown by the leader of his own army, General Tito Okello Lutwa. During the second Obote regime a new guerilla National Resistance Movement had gathered momentum in the countryside, under the leadership of a civilian, Dr Yoweri Kaguta Museveni. Because of the superior discipline of the guerillas, the Lutwa regime was ousted by the National Resistance Movement on 26 January, 1986, under the leadership of President Museveni (Gertzel, 1991: 60).

President Museveni took a pragmatic approach to pacifying the country and to rebuilding the economy. Although resistance to the new regime has persisted in some areas, especially in the north, he has made rapid progress in restoring law and order. It is significant that it was possible to conduct the UDHS in all except the northern parts of the country less than three years after Museveni assumed the presidency. Asian businessmen were invited back to Uganda in the early 1990s and granted taxation incentives to assist them with the re-establishment of commercial activities. When the writer visited Kampala in 1991 the scars of bullet holes and fire damage could be seen throughout the city centre. Many buildings were boarded up and awaiting repair. When a return visit was made 18 months later, a noticeable improvement was evident. There had been considerable construction and repair of buildings, many businesses had reopened and there was more streetside commerce than before.

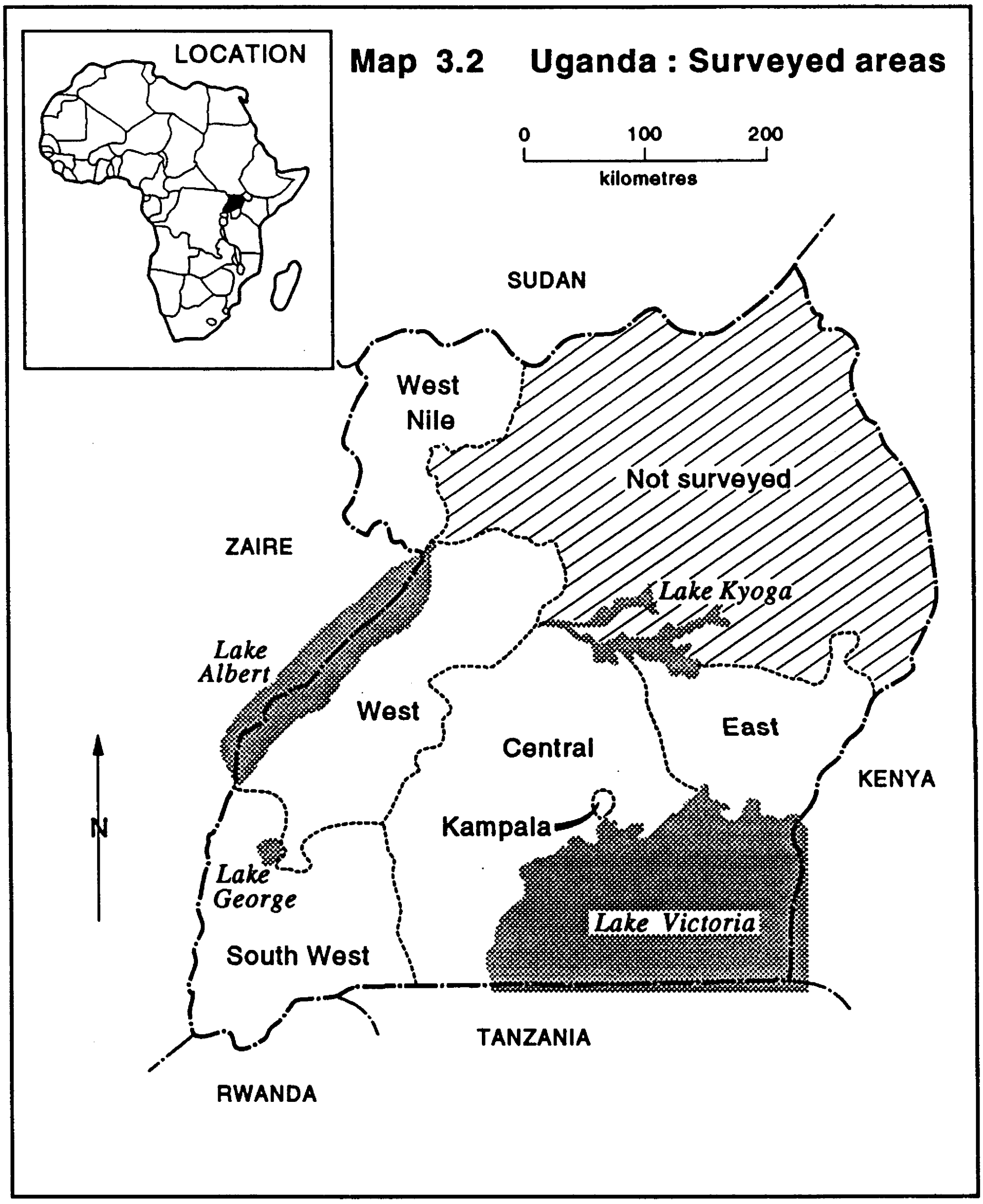
3.3.3 Population and settlement

The population of Uganda exhibits considerable ethnic diversity. UDHS respondents included 19 tribal groups, even though most of the northern part of the country was not included in the sample (see Map 3.2). According to Langlands (1975: 6-7) some 60 per cent of the total population are Bantu speakers, including the Ganda, Soga, Toro, Nyoro, Nyankole, Kiga, Konjo, Aba and Gisu, who are predominantly cultivators occupying the southern and western areas of the country. Around 13 per cent are Nilo-Hamitic cattle herders, including the Karamojong, Teso and Sebei, who occupy the northeastern areas. The northern areas are populated by Nilotic cultivators, including the Acholi, Alur, Jonam, Kakwa and Lango, who comprise around 15 per cent of the population. About 5 per cent are Sudanics, mostly Madi and Lugbara, who occupy the north-western corner.

In addition to the major indigenous ethnic groups, influxes of migrants from neighbouring countries, as well as fluctuating European and Asian populations, have added to the diversity. However, most expatriates left Uganda during the period of protracted civil strife and the citizen population is now almost entirely African. Langlands (1975: 7) considered the ethnic variety in the population to be a fundamental factor underlying the disease pattern, with genetic factors such as Haemoglobin-S and intestinal lactase deficiency reflecting long-term exposure to malaria or particular dietary habits.

Some 90 per cent of the Ugandan population is engaged primarily in subsistence agriculture or cattle herding. Urban dwellers tend to retain economic ties with rural communities, and remit cash and goods to rural relatives in return for staple foods (UNICEF, 1989: 14). Langlands (1975: 8) observed that the urban population was exposed to different disease risk factors from rural dwellers as a result of poor diet, overcrowded housing, contaminated water and prostitution. Among diseases exacerbated by the crowded urban conditions were alcoholism, venereal disease, typhoid, dysentery, hepatitis and childhood measles (Langlands, 1975: 8). To this must now be added AIDS, which has become endemic in both rural and urban Uganda and which was already claiming the lives of adults, and possibly also children, when the UDHS was carried out.

As a result of high fertility, population growth has been substantial in recent decades, despite high mortality from civil conflict. The 1948 census recorded a population of five million, which had increased to 6.5 million by the census of 1959. The 1969 census


LOCATION
Map 3.2 Uganda : Surveyed areas
0
100
200
kilometres
SUDAN
West
Nile
Not surveyed
ZAIRE
Lake Kyoga
Lake
Albert
West
Central
East
KENYA
N
Kampala
Lake
George
Lake Victoria
South West
TANZANIA
RWANDA

recorded 9.5 million, and the 1980 figure was 12,636,179. The TFR was estimated to have increased from 5.9 in 1948 to 7.4 in 1980. Since no detailed analysis of the 1980 census is available the UDHS estimated the total population for 1988 on the basis of projections of the 1969 total. Assuming a constant growth rate of 2.8 per cent, the projected total is almost 16 million (UMOH & IRD, 1989: 2). A growth rate of at least this order was confirmed by the most recent census of 1991, which returned a total population of 16,582,600 (United Nations, 1992: 12).

UNICEF (1993) estimated that 11 per cent of the population are urban residents. Kampala is the main urban area, and is a sizeable city, showing the influence of the British colonial period in its paved roads, gardens and monuments. Most of the country's political and administrative activities are located in Kampala and neighbouring Entebbe. Shorter (1974: 50) termed Kampala 'a super-city' because of this concentration, and argued that control of Kampala is the key to control of the whole country. Kampala is also home to Makerere University, a leading African academic institution, while the Mulago Hospital is an important centre of teaching and medical research. However, many of the residential areas of the city have an 'urban village' character, as shown in Plate Two. Small clusters of mud brick houses are surrounded by garden plots with bananas, vegetables and chickens. Here and there long-horned cattle graze the margins of sports fields and busy urban roadsides. Most urban residents have access to a small plot of cultivable land to supplement their food supply (UNICEF, 1989).

3.3.4 Health and nutrition

The long period of civil strife severely damaged the economic infrastructure, including health facilities and sanitation. Prior to the period of unrest, a substantial network of health facilities existed. The Mulago hospital was completed by the British just before independence (Brett, 1992: 17), and a further 20 district hospitals were constructed to improve services in the decade following independence (Langlands, 1975; Brett, 1992: 17). Scheyer and Dunlop (1985: 25) commented that in 1971 Uganda's health systems had reached an impressive level, but by 1978 a near total breakdown of health service administration had occurred.

In 1988 a total of 792 government health facilities offered free services, and 145 non-government hospitals and health centres which charged small fees. However, many were in a poor state of repair and lacked basic supplies, including bed linen (UNICEF, 1989: 49). Some of the women interviewed by the writer in 1992 reported that, since

PLATE TWO: Suburban Scenes, Kampala

queues at government child health clinics are long and nurses expect a gift of food or drink, many mothers prefer to pay a small fee and use non-government facilities. Wotton (1985: 76) reported that in Mulago Hospital in the period 1982-1983, 29 per cent of children admitted with measles died, largely because of inadequate attention to hydration, chest care, nutrition, medical management and nursing care. The complex administration of government health facilities, which is shared between local and central government, has contributed to poor service by restricting funds and causing many posts to be left vacant (UNICEF, 1989: 9)

As a result of legislation governing sanitary waste disposal, an estimated 80-90 per cent of homes had latrine facilities by 1962 (Hebert and Ssentamu, 1985: 117). However, conditions deteriorated during the period of civil strife, and by 1983 only 30 per cent of all existing homes had a functioning latrine, and only 33 per cent of boreholes were functioning (Hebert and Ssentamu, 1985: 117). Hebert and Ssentamu (1985: 119) estimated that 44 per cent of all hospital admissions in the early 1980s were for diseases associated with poor sanitation and water quality, and that water-related diseases accounted for 31 per cent of hospital deaths.

The UDHS found 49.3 per cent of children aged 12-23 months had a health card, and of these 47.7 per cent were fully immunized (UMOH & IRD, 1989: 64). This compares very favourably with an estimated less than 1 per cent of all Ugandan children fully immunized in 1984 (Dodge and Henderson, 1985: 213). However, in the same year, slightly better figures were reported for Kasangati District, while as many as 21 per cent of infants and 38 per cent of children aged 1-4 years were fully immunized in Mbale District (Dodge and Henderson, 1985: 213).

Although Uganda has considerable capacity to produce food, FAO (1987a: 7) estimated that the availability of food, measured as average kcal per capita, declined from 2260 in 1969-71 to 1797 in 1979-81. This is almost certainly due to political instability. In the later period the composition of available food was estimated as 30.4 per cent from cereals, 18.4 per cent from roots and tubers, 14 per cent from pulses and nuts, 7.5 per cent from animal products, 2.9 per cent from sugar, and 26.8 from other sources, including bananas, which are an important staple food in Uganda (FAO, 1987a: 8).

Sserunjogi (1985: 19-20) documented the spread of malnutrition during the 1960s and 1970s, largely because mothers lacked education in correct nutrition. Children's diets tend to be deficient in protein and fat, comprising bulky but infrequent meals of starchy staples, which are served without the sauces and accompaniments offered to men. Hunger is thus satisfied, but smaller children, especially, are unable to consume sufficient amounts of this low-protein, low-fat food to obtain essential nutrients (Sserunjogi, 1985: 26-31). Some beliefs about food also contribute to malnutrition. For example, women the present writer interviewed in Kampala said that, customarily, females are forbidden to eat eggs or chicken.

Langlands (1975: 9) noted the correlation in Uganda of bananas as a staple food and childhood protein deficiency. Bananas are the staple in most of the Bantu areas in the southern half of the country, which also are the high rainfall areas. This leads to the aggravation of malnutrition by hookworm, which thrives in wet regions, especially in the shelter of bananas trees. Similarly, McCance and Rutishauser (1975: 89) related the prevalence of kwashiorkor and marasmus to staple food crops, and found that the northern areas, where millet is the staple grain, were least affected by both conditions, although occasional food shortages occur. Marasmus was most common in Karamoja, where sorghum is the staple grain, the cassava areas to the west and the high rainfall banana areas in the southern part of the country.

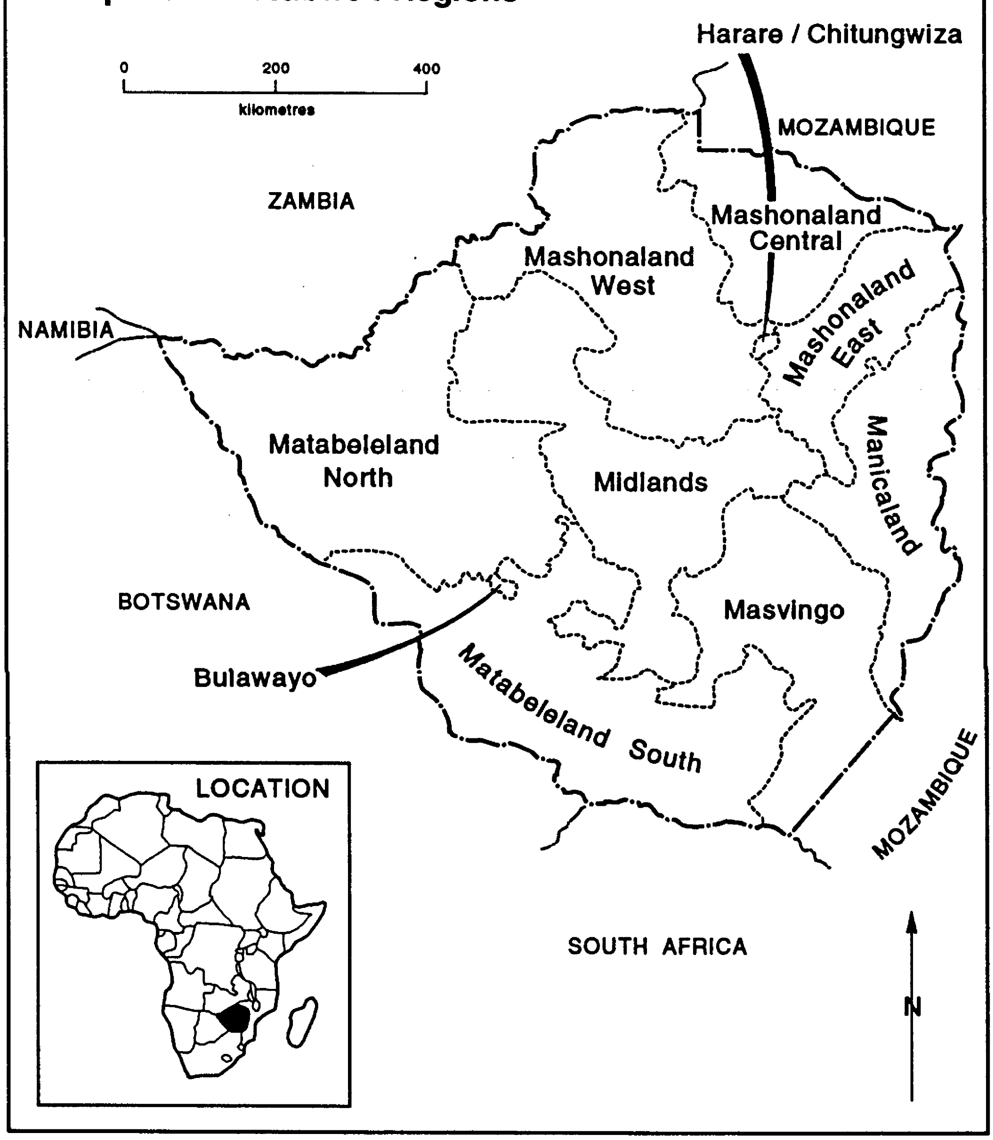
3.4 ZIMBABWE

3.4.1 Physical features

With a land area of 391,000 square kilometres, Zimbabwe is the largest of the three study countries. To the north it borders Zambia, to the east Mozambique, and to the south-west Botswana (Map 3.3). The south-western regions are in close proximity to the Kalahari Desert, and, unlike Burundi and Uganda, much of Zimbabwe is subject to irregular rainfall. On the basis of a relatively short history of climatic recording, the mean national annual rainfall is said to be 650 mm, but of the 12 years 1980-1991, eight recorded less than the mean, with 1991 registering only 320 mm, less than half the mean (reported in *The Herald*, Harare, May, 1992: 7). In addition to low rainfall, large areas of the country have poor, stoney soils or are strewn with massive boulders. Only a small proportion of the total land area can be regarded as prime agricultural land.

Chavunduka (1982: 22) classified Zimbabwe into five natural agro-ecological zones. Region I, which comprises only 2 per cent of the total land area, is suited to specialized and diversified farming. It is characterized by rainfalls above 1,000 mm per year and comparatively low temperatures, which minimize water loss through evaporation. This region supports forestry, fruit farming and intensive livestock production. Region II

Map 3.3 Zimbabwe : Regions



occupies 15 per cent of the land area and supports intensive farming, with rainfalls of 750-1,000 mm, generally confined to the summer months. Intensive farming of grains, vegetables and cash crops and also livestock farming are practiced. Nineteen per cent of the land area can be classified as Region III, which supports semi-intensive farming, with irregular rainfalls of 650-800 mm and frequent dry spells. This is an area of marginal production of maize, tobacco and cotton. Region IV, which comprises 37 per cent of the land area, is suited only to semi-extensive farming with annual rainfalls of 450-650 mm, and prolonged dry spells. Livestock production predominates in this region. Finally, 27 per cent of the land area, classified as Region V, is suited only to extensive farming, with erratic rainfalls of less than 450 mm per year. Extensive cattle- and game-ranching are the only feasible land use activities in Region V, except where irrigation is possible.

The more productive Regions I and II are on the higher terrain to the north-east of the country. Aridity increases to the south and west. The arable and marginally arable Regions I, II and III together comprise only about one-third of the total Zimbabwe land area. The balance is arid and relatively poor land.

Overlaying the five region types is a division of farming types between the largely expatriate owned and operated large-scale commercial farming, small-scale commercial farming and communal lands for the African population. Overall, large-scale commercial farms occupy 40 per cent of the land area, while communal lands occupy 42 per cent. The remainder is used for small-scale commercial farms and other activities, or is not used. Large-scale commercial farms occupy 63, 74 and 44 per cent respectively of the most productive Regions I, II and III, while communal lands occupy the largest proportion of the poorer Regions IV and V.

3.4.2 History and development

Zimbabwe's agricultural colonization began with the arrival of Cecil Rhodes in 1890. He was searching for a goldfield to rival Witwatersrand in the colony of South Africa (Griffiths, 1984: 100). In the absence of gold he settled for arable land. By 1899 6.3 million hectares of the best land had been annexed by the British South Africa Company for future use. This division of land was reinforced by the Land Acts of the 1930s. Later, as the gesture of conciliation, the Rhodesian Front's Land Tenure Act of 1969 reallocated the 36 million hectares of usable land equally between Europeans and Africans, even though the population ratio was 1: 21 in favour of the Africans (Griffiths 1984: 100). Munslow (1985: 43) pointed out that generally Europeans have been allocated the best land, while Africans have the worst. This pattern has persisted to a considerable extent, even after independence.

Prior to British colonization Zimbabwe was the centre of several major African civilizations. By the mid-fifteenth century the Monomatapa King Mutota had established an empire which encompassed much of present day Mozambique and Zambia. Agricultural produce, metal work and textiles were traded with Arab merchants, but this prosperity was subsequently destroyed by conflict with the Portuguese in the sixteenth century (Crowther, 1989: 1112). The decline of the Monomatapas was paralleled by the rise of the Rozwi empire to the south-west, which established the major fortified city of Great Zimbabwe, and also Khami and Dhlo-Dhlo.

The Rozwi Empire was, in turn, destroyed when the Zulu leader, King Mzilikazi, invaded Matabeleland in the mid-nineteenth century. King Mzilikazi based his Ndebele kingdom near the present site of Bulawayo, and was later succeeded by his son, King Lobengula (Crowther, 1989: 1112). Increasing pressure from European settlers led to the war of 1893, in which the Ndebele were defeated by superior weaponry. Northern and Southern Rhodesia came under British control when the British South Africa Company gained authority to operate north of the Transvaal. Southern Rhodesia was subsequently created in 1898 from the union of Mashonaland and Matabeleland (Hailey, 1938: 157). By 1904 there were 12,000 white settlers in Northern and Southern Rhodesia, and by 1935 the whites in Southern Rhodesia alone numbered 55,000 (Hailey, 1938: 109).

In a white dominated referendum of 1922, the territory voted to remain self-governing rather than join the Union of South Africa. Northern and Southern Rhodesia were later declared as separate colonies, although British supervision of native affairs continued to be exercised through the High Commissioner for South Africa (Hailey, 1938: 158). The colonial attitude to the African population is evident in Hailey's (1938: 377) reference to 'problems which arose from the dispossession of natives from lands required for colonization'. Among the solutions to these 'problems' he included removing native squatters from European lands and regulating their movement and access to urban areas.

The dominant position of the Europeans and an on-going supply of black labour were secured in the 1930s by a series of Land Acts and the Labour Law which prevented Africans from owning arable land or entering skilled trades and professions. This was supported by an education system which disadvantaged Africans in the labour market.

In 1935-6 government expenditure on European education in Southern Rhodesia was more than 300,000 pounds, compared with some 72,000 pounds for African education, even though there were more than ten times as many African pupils as European pupils in schools (Hailey, 1938: Table XI). Ninety-seven per cent of the Africans were in Standard II or lower grades, with only 0.1 per cent above Standard IV (Hailey, 1938: Table X). In 1970 average expenditure on the education of Europeans, Asians and Coloureds was Z $ 234-239 compared with Z $ 24-48 for Blacks, while the teacher-student ratios were 1:29 and 1:42 respectively (Godwin and Hancock, 1993: 34). As recently as 1979 only 42 per cent of all children of primary school age attended school, and secondary school places were available for less than 20 per cent of primary school leavers. A 1978 study found 45 per cent of black adults were illiterate and 12.5 per cent semi-literate (Stoneman and Cliffe, 1989: 168).

The ready availability of black labour was further reinforced by the federation of the Rhodesias and Nyasaland (later Malawi) in 1953 (Crowther, 1994: 1113). This ensured free access to the large labour pool in Nyasaland and allowed substantial transfers of capital from Northern Rhodesia and Nyasaland to Southern Rhodesia. Proposals in the 1950s and 1960s to reduce inequalities between the black and white populations were responsible for the downfall of two white prime ministers of Southern Rhodesia.

Two black political parties emerged from the increasing dissatisfaction with the treatment of Africans by the white minority: the Shona-dominated Zimbabwe African People's Union (ZAPU), led by Mr Joshua Nkomo, and the Ndebele-dominated Zimbabwe African National Union (ZANU), led by Mr Ndabaningi Sithole. The disintegration of the Federation of Nyasaland after only ten years resulted in the independence of Malawi and Zambia under African leadership. However, the British government declined to grant independence to Southern Rhodesia, because of the refusal of the white minority government to allow better conditions for blacks. Mr Ian Smith became leader of the white Rhodesian Front Party, and, after winning every seat in government in 1965, promulgated the Unilateral Declaration of Independence (UDI) (Rowe, 1993: 37).

Despite the imposition of economic sanctions by Britain and many other countries, the Smith regime prospered, with assistance from white-dominated South Africa. Mzite (1981: 3) reported that the first signs of resistance were evident as early as 1966. While Britain made repeated attempts to settle the affair by political negotiation, the blacks fought the Smith regime with guerilla tactics. ZANU established bases in

Mozambique and ZAPU in Zambia, with guerilla fighters also training in Tanzania, the USSR and other sympathetic countries (Raeburn, 1978).

The war was protracted and bloody. The white minority were well organised with superior armaments, but vastly out-numbered by the blacks. Atrocities were committed by both sides (see accounts in Raeburn, 1978). Sanders (1982: 209) describes the deliberate use of food as a weapon by the white minority, with cattle and crops destroyed and food rations restricted to prevent surpluses reaching the guerillas.

Although it managed to contain the African Resistance, the Smith regime found its support gradually eroded by widespread international opposition and economic sanctions. In 1980 a settlement was reached, and the British government conceded power to the black majority. Independence was declared, and ZANU's Mr Robert Mugabe headed a black government in which 20 seats were reserved for whites.

Despite the ravages and racial bitterness of the war years, sporadic episodes of conflict following independence, and increasing rivalry and bloodshed between ZANU and ZAPU, Zimbabwe quickly achieved stability. President Mugabe promoted racial harmony and asked the people to put the past behind them. Today there is surprisingly little racial animosity in Zimbabwe. President Mugabe set about forming a one-party state, and resolved the political unrest by creating a new combined party, ZANU-PF (Rowe, 1993: 37-39). However, his abolition in 1988 of the 20 white seats in parliament, and his nationalist orientation, has led to sustained white emigration, in spite of currency controls that allow emigrants to take only a few hundred dollars out of the country.

Zimbabwe inherited a well-developed social and economic infrastructure from the period of British rule, which suffered only relatively minor damage during the war of independence. In 1990 Zimbabwe's modest per capita GNP of US $ 640 was one of the highest among the independent black-governed countries South of the Sahara, surpassed only by mineral-rich Botswana and Namibia and oil-rich Gabon. Zimbabwe is regarded by many as a model for post-colonial economic development.

Nonetheless, substantial income inequalities persist. In Loewenson's (1990: 29-32) opinion the first and most profound inequality is in land ownership. She argued that the benefits of investment and better conditions in the large-scale farm sector are not passed on to the farm labour communities, who have very low incomes and poor diets. Fifty-seven per cent of households in the community areas of Mashonaland West suffer food insecurity, even during normal agricultural seasons, and there are substantial wage inequalities in the formal and informal sectors (Loewenson, 1990: 32, 35-36).

Kinsey (1982) described the extensive land resettlement scheme introduced by the government following independence, which had the objective of reducing white control of agriculture. However, he commented that, although the average holding size was 60-70 hectares in the drier regions, where the bulk of resettlement has occurred, the amount of arable land per holding averaged only five hectares. This is generally insufficient to feed a family, and, as shown in the following analysis, poor child growth attainment is common in resettlement areas.

3.4.3 Population and settlement

The first official census of the area which has become Zimbabwe was taken in 1961/62, in separate rounds for Africans and non-Africans, one year apart (World Bank, 1989: 3). Fertility and mortality data were not collected, and age was available only in broad groupings. The total population count was just over 4 million. The 1969 census also was collected as separate rounds for Africans and non-Africans, but only one month apart. It included fertility and mortality questions for Africans, but not for the five per cent of the population who were non-Africans. The 1969 total was 4,846,930 (World Bank, 1989: 37).

The 1982 census was the first in the post-independence period, and the first to be conducted as a single operation. It returned a national population total of 7,608,000. This climbed to 10,401,767 in the 1992 census, giving an intercensal growth rate for the ten-year period of 3.1 per cent Zimbabwe Central Statistical Office, (ZCSO), 1992a: 10). Three major surveys in the intercensal period, the 1984 Reproductive Health Survey (Zimbabwe National Family Planning Council (ZNFPC), 1985), the 1987 Intercensal Demographic Survey (ZCSO, 1991), and the 1988 Demographic and Health Survey (ZCSO & IRD, 1989) yielded varying estimates of fertility and mortality, which conflicted with each other as well as with those derived from the 1982 census. A subsequent combined demographic analysis (ZCSO, 1992b) reanalysed these data and adjusted the results to produce consistent estimates.

The combined analysis estimated the national TFR in 1987 as 6.7 children per woman, which is substantially greater than the ZDHS estimate of 5.5 (ZCSO & IRD, 1989: xix; ZCSO, 1992b: 22). Mortality estimates also vary considerably, as discussed in Chapter Four. The demographic analysis of the 1992 census was not available at the time of writing, but as the census is believed to have good coverage, the results may resolve the matter of fertility and mortality levels.

Ethnicity is not usually asked in Zimbabwean censuses and surveys, but Griffiths (1984: 100) estimated that 80 per cent of Zimbabwe's population were Shona and 15 per cent Ndebele, with the balance white or migrant. In the 1982 census report 98 per cent of the citizen population were classified as African (ZCSO, 1985: 12). In 1992 the most populous province was Manicaland, followed by Midlands and Masvingo. Beach (1990: 52) noted that in 1920 the population distribution throughout the country was uneven. Most settlement was in the eastern provinces, where rainfalls are higher, while the west, north-west and south were only sparsely populated. This pattern has persisted, although a comparison of distributions for 1920 and 1982 indicates an intensification of settlement in the drier communal land areas to the west, north-west and south (ZCSO, DSG and UZ, 1985). However, even the highest provincial density in 1992 of 42 per square kilometre for Manicaland and the national density of 27 are low compared with 182 for Burundi as a whole and 80 for Uganda (United Nations, 1992:14-15).

In 1992 some 20 per cent of Zimbabwe's population resided in the two main urban complexes, Harare / Chitungwiza and Bulawayo (ZCSO, 1992a: 15). Harare, formerly known as Salisbury, is an attractive and spacious English-style city. It has an extensive commercial centre, government offices, tree-lined streets and many parks and gardens. Most non-Africans and high income Africans live in good quality, detached suburban housing, but cheaper housing alternatives also are available. Chitungwiza, some 20 kilometres south of Harare, is a predominantly black township established in the 1970s to accommodate the rapid urbanization of Zimbabwe's black population. Most Chitungwiza workers commute to Harare each day, usually by bus, to work for relatively poor wages in the manufacturing and service sectors of the Harare economy. The combined population of the greater Harare / Chitungwiza area was some 1.5 million in 1991 (ZCSO, 1992a: 15). Bulawayo is less than half as big as Harare, but also spacious and English in character. There is no separate township for black workers in Bulawayo, but most of the black population live in the cheaper and more crowded areas.

3.4.4 Health and nutrition

Compared to Burundi and Uganda, the availability of health services in Zimbabwe is good, with an extensive network of district hospitals, mission facilities and health centres. The Government's national target is to have a health provider within eight kilometres of each person (ZCSO & IRD, 1991: xiii). On the basis of the Zimbabwe Service Availability Survey (ZSAS), it was estimated that more than 80 per cent of rural married women live within eight kilometres of a MCH facility, and 96 per cent of urban women. Nearly all women were estimated to be within 30 kilometres of basic health supplies and equipment, including iron tablets, refrigerators and tetanus vaccines, and 75 per cent had access to running water and telephones (ZCSO & IRD, 1991: xiii).

Primary health care has been promoted vigorously in the past decade. By 1988 full child immunization coverage in rural areas ranged from 56 per cent in Mashonaland Central to 71 per cent in Midlands. In urban areas it was estimated at 93 per cent in Bulawayo, 80 per cent in Harare and 85 per cent in Chitungwiza (Loewenson, 1990: 79). Similarly, by 1988 maternal health care was available to 96 per cent of urban residents, 94 per cent in large-scale farm areas and 90 per cent in communal areas (Zimbabwe, Ministry of Health, 1988a: 6-7). Malaria remains the most common notifiable disease, followed by diarrhoea and venereal diseases. As in Burundi and Uganda, AIDS has become a significant health problem in recent years. The number of tuberculosis cases has tended to decline with a 1985 incidence rate of only 57 per 100,000, but the case fatality rate remains at around 3 per cent (Zimbabwe, Ministry of Health, 1988b: 5).

The average ratio of persons to hospital beds ranged from 1: 330 in Matabeleland South to 1: 736 in Mashonaland East in 1983 (UNICEF, 1985: 143). However, these figures do not reflect differentials in the access of various sectors of the population. In 1987 Zimbabwe had 274 rural health centres, but Loewenson (1990: 76) pointed out that their distribution is not uniform across provinces, with Matabeleland South the worst served and Midlands the best served in 1983.

Loewenson (1990: 75-76) also reported regional disparities in health manpower, with some 70 per cent of doctors concentrated in urban areas, while mission hospitals, which provide most rural hospital services, are understaffed. This pattern of concentration also is reflected in the distribution of nursing staff and other health personnel. ZCSO and IRD (1991: xiii) reported that the major problem identified by the ZSAS was the high proportion of women living near facilities with shortages of vaccines and medicines, which ranged up to 61 per cent in urban areas. The distribution of drugs and medical supplies in the public sector through the Essential Drugs Action Programme is based on a list of essential drugs. Only the private sector is permitted to import and utilize drugs not on this list, while even commonly prescribed drugs are not always available at public facilities. This leads to increased costs and discriminates against the poor (Loewenson, 1990: 77-78). Nonetheless, ZDHS found 77.6 per cent of children aged 12-23 months with health cards, of whom 85.9 per cent were fully immunized.

FAO (1987a) listed Zimbabwe among the countries where availability of food, measured in average kcal per capita per day, increased slightly in the ten-year period 1971-81, from 2,056 in 1969-71 to 2,094 in 1979-81. In the latter period this was composed of 62.8 per cent from cereals, 1.2 per cent from roots and tubers, 7.6 per cent from pulses and nuts, 7.3 per cent from animal products, 9.6 per cent from sugar and 11.5 per cent from other sources (FAO, 1987a: 10). The World Bank (1991: 27) presented similar data and noted that the proportion of calories derived from protein and fat has tended to decline, with only an average of 10 per cent from protein and 17 per cent from fat in 1987.

Tredgold (1986) listed more than three hundred edible plants of Zimbabwe, including staples, relishes and plants that are used to supplement diets in times of food shortage. She noted also that a wide variety of insects, such as locusts, caterpillars, flying ants, crickets and Christmas beetles, are commonly included in Zimbabwean diets. However, children do not necessarily consume the wide range of foods available to adults. The World Bank (1991: 25) referred to a 1981 study which found that up to 87 per cent of children on large-scale commercial farms and 16 per cent of urban children never consumed milk, eggs or beans, and seldom ate meat. Several informants told the writer that it is considered poor etiquette to accustom children to eating meat and eggs as they may request them when visiting another household. This could cause embarrassment if that household is too poor to provide such food. Moreover, as in Uganda, there is a traditional taboo against women and girls eating eggs and chickens.

Zimbabwe is generally deficient in iodine, and goitre is endemic in every province (World Bank, 1991: 15). Iodine deficiency rates of 45.9 per cent were reported in 1966, and a prevalence of 73 per cent was found in a 1986 survey of primary school children in the Wedza region (Hetzel, 1989: 217). In 1988 the Total Goitre Rate (TGR) for the nation as a whole was 44 per cent and the severe Visible Goitre Rate (VGR) was 4 per cent (World Bank, 1991: 15). Other nutritional problems noted as of particular concern to the Ministry of Health are malnutrition, Vitamin A and B deficiencies and anaemia (Hetzel, 1989: 217).

The Nutrition Unit in the Ministry of Health actively promotes nutrition education, growth monitoring and surveillance, and manages supplementary feeding programmes. By 1986 more than 90 per cent of children possessed a health card on which their weight was recorded from time to time (Loewenson, 1990: 82). The Children's Supplementary Feeding Programme was started by NGOs in 1980, and taken over by the Ministry of Health in the following year. In times of hardship the programme provides a daily food supplement to undernourished children, mostly in communal areas. At the peak of the drought period, between 1981 and 1986, more than 250,000 children received supplementation (Loewenson, 1990: 84). The programme peaked again in 1992, when some 800,000 were receiving daily supplements of mealie meal flour, ground nuts and oil (J. Tagwireyi, personal communication).

It is evident from the foregoing discussion that Zimbabwean women and children have considerably better access to health facilities than do those in Burundi and Uganda, although many live in a harsher natural environment. Differing historical and political backgrounds have been largely responsible for this situation. It is against this background that the following analysis must be viewed. The remainder of this chapter gives details of sample design and data limitations. However, it is essential to bear in mind the distinctive characteristics of the three countries, as well as sampling differences, when considering the findings of this study.

3.5 SAMPLE DESIGN

The DHS-I objective was to obtain a nationally representative self-weighting sample of women aged 15-49 in all surveyed countries (BMI & IRD, 1988: 115; UMOH & IRD, 1989: 79; ZCSO & IRD, 1989: 113). However, in practice this was not always possible, and of the three data sets used in this study only Zimbabwe is self-weighting. Due to problems of national security in Uganda, nine districts, containing some 20 per cent of the total population, were excluded from the sample frame (UMOH & IRD, 1989: 79) and there was over-sampling of urban areas in both Burundi and Uganda.

Burundi has eight provinces, which are subdivided into a total of 18 districts. These districts are in turn subdivided into 79 *communes*, including the urban *commune* of Bujumbura. Each *commune* is split into a number of *collines* (census hills), averaging 20-40 per commune, which correspond roughly to villages in other countries (Barandereka and Berciu, 1981: 52). Each *colline* is subdivided into two or three *sous-collines* which contain a number of *rugos* or *menages*. In order to compensate for variability in size of *sous-collines*, some were grouped together or subdivided for sampling purposes (BMI & IRD, 1988: 118).

A three-stage sample was drawn. In rural areas the highest level was *collines*, selected with a probability proportional to population size. From these, *sous-collines* were selected, also with a probability proportional to population size. *Rugos* were then selected with a probability proportional to the size of the *sous-colline*, with the constraint that the overall sampling fraction would be 1/240 (BMI & IRD, 1988: 119). Urban areas were divided into segments based on settlement densities in the various quarters of the towns, with each containing 500-600 people, i.e. comparable in size to a *sous-colline*. One in every eight segments was selected, and from these one *menage* in six was selected for interview. Since less than 5 per cent of Burundi's population is urban, urban areas were oversampled fivefold to ensure representation, with a sampling fraction of 1/48 (BMI & IRD, 1988: 117).

In Uganda the primary sampling units were sub-parishes in rural areas, selected with a probability proportional to the number of registered tax payers. All households in the selected sub-parishes were listed, and individual households for interview were chosen from these lists, with probability proportional to sub-parish size, constrained by the overall sampling fraction. In urban areas Resistance Council One (RC1) administrative units were listed, and 200 were selected with equal probability. Households in the selected units were listed and 50 RC1s were selected with a probability proportional to size. Twenty households were then systematically selected from each (UMOH & IRD, 1989: 5). The result was a stratified, weighted sample selected from 206 clusters (UMOH & IRD, 1989: 79). The South West region and part of Central were apparently over-sampled, although the factor is not stated, while the urban sector was over-sampled by a factor of three (UMOH & IRD, 1989: 79).

The Zimbabwe sample was two-stage, stratified by eight provinces and six sectors, and self-weighting at the household level. It was based on the Revised Zimbabwe Master Sample prepared for the 1987 and 1988 Intercensal Demographic Survey rounds carried out under the Zimbabwe National Household Survey Capability Programme. The primary sampling units were census enumeration areas, selected with probability proportional to the number of households counted in the 1982 census. Households were drawn systematically from the 167 selected census enumeration areas. Fifty-three of the selected enumeration areas were urban and 114 rural.

In each country all members of each selected household were listed, and then all women aged 15-49 were interviewed. General socio-economic data and complete birth histories were collected from each woman, and health and nutrition information was collected for their children aged 60 months and under. Measurements were taken from children aged 3-36 months in Burundi, 0-60 months in Uganda and 3-60 months in Zimbabwe. Burundais husbands were asked about contraception and fertility preferences, but data for husbands are not used in this study since husbands were not interviewed in Uganda and Zimbabwe.

Each data set includes some unmarried women, as well as both mothers who did and mothers who did not avail themselves of health facilities, and both healthy and sick children. In this respect these data sets are better suited to a study of health care and growth attainment than clinic-based studies, which are biased towards mothers who habitually make use of health facilities or have especially sickly children.

Table 3.2: COMPOSITION OF DHS SAMPLES: BURUNDI, UGANDA AND ZIMBABWE

Country	Households (% of target)	Women aged 15-49 (% of target)	Children up to 60 months	Children with measurements (% of target)
Burundi	3955 (99.1)	3970 (98.1)	3885	1930 (91.7)
Uganda	5123 (99.6)	4730 (98.4)	4730	3789 (80.1)
Zimbabwe	4107 (94.7)	4201 (94.0)	3527	2389 (77.1)

SOURCE: BMI & IRD, 1988: UMOH & IRD, 1989; ZCSO & IRD, 1989

Surveys were carried out collaboratively between DHS and local government departments, using experienced local field staff who generally had secondary education or higher, and a knowledge of local languages. Field staff were trained for up to four weeks by experienced staff from DHS headquarters, who also supervised and monitored data collection (BMI & IRD, 1988: 5-8, UMOH & IRD, 1989: 4-5; ZCSO & IRD, 1989: 9-10).

A summary report was published for each country before the data sets were released for analysis. These reports describe the surveys, including the sampling frame, sample weights, methods of collection and the basis for calculating the sampling error. They present basic descriptive data, comprising frequency distributions and cross-tabulations of selected variables. The reports do not include any multi-variate analysis.

The present study follows the DHS reports and uses the supplied sample weights for the analysis of Burundi and Uganda, and treats Zimbabwe as self-weighting. However, totals in the background tables may not match exactly those in the DHS reports. In some cases this is because the present analysis of Burundi and Zimbabwe is based on second release, cleaned versions of the data sets, classified as IR01. The Uganda analysis is based on an original data set which had received only preliminary cleaning, classified as IR00. Another source of variation from the DHS country reports is the exclusion of certain cases, for example some ethnic groups or multiple births, as described below.

3.6 DATA QUALITY

An assessment of the quality of data collected in the first round of surveys, DHS-I, was made by DHS (Arnold, 1990). This report concentrated on errors of non-response and misreporting of dates. It concluded that generally the quality of DHS data is good. Various published papers have used these data to look at immunization in Burundi (Dunn and Yumkella, 1990), child mortality in Burundi (Ndikumasabo, Werner and Mukiza-Gapere, 1990) and numerous others presented at the DHS World Conference of August, 1991. These studies, as well as the summary reports, confirm that the data quality is good, although there are some limitations to its scope.

Specific deficiencies of relevance to this study are missing age at death for some dead children, and instances of heaping of ages of live children. In fact, although age at death was incomplete for up to 5 per cent of cases in some countries, less than 2 per cent of dead children lacked an age at death in the Burundi, Uganda and Zimbabwe data sets (Sullivan, Bicego and Rutstein, 1990: 121). However, age ratios[1] suggest that heaping of children's ages was most pronounced at age six in Uganda, with a ratio of 124, and age 10 in Burundi, with a ratio of 122. Ratios at other ages do not deviate greatly from 100.

A potential problem for this study is displacement of birth dates by interviewers who wished to reduce the number of women eligible for interview and/or the number of children about whom detailed health questions must be asked (Arnold, 1991b: 785,

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$$\text{Age ratio at age x} = \frac{P_x}{\frac{1}{2}(P_{x-1} + P_{x+1})}$$

791). Since the sample was household based, interviewers had to spend more time in households with more than one eligible woman than in households with one or with no eligible women. Moreover, the questionnaire was structured so that the duration of interview was greatly increased if a woman had children under age five. Arnold pointed out that such a structure inevitably encourages interviewers to 'age' women and children out of the eligible group in order to reduce their workload (Arnold, 1991b: 785). For example, this probably explains the heaping at age six in Uganda.

It also appears that in some countries the modular questionnaire design has resulted in heaping of the numbers of women at the margins outside the eligible age groups, that is, at ages 14 and 50 (Arnold, 1991b: 794). Distortion at age 50 is pronounced in Uganda and Burundi, but negligible at age 14 in all three countries (Arnold 1991b: 799). Similarly, in Burundi only, there appears to be some heaping of births in the months preceding interview, and at age 61 months (Arnold, 1991b: 801). However, there does not appear to be heaping in Burundi after age 36 months, the limit of eligibility for measurement. This suggests that interviewers were more concerned with discarding the whole set of questions for children five years and under rather than only the task of measurement. Since interviewing and measurement were carried out by different teams this seems plausible.

Although displacement of some children's ages could have serious consequences for studies of fertility and child mortality, it is not a serious limitation for the present study. The analysis of growth attainment depends upon accuracy of age and measurements for those who have been selected, rather than upon the selection of children in a particular age range. Deliberate age displacement errors were probably distributed randomly throughout the country. It is therefore unlikely that the suspected age displacement has resulted in a potentially more serious bias, the systematic omission of children with a particular growth attainment.

The accuracy of measurements is an issue of more importance. It is generally agreed that weights of very young children can fluctuate significantly from day to day, while it is difficult to measure their length accurately. Some nutritionists consider that such measurements are of little value for children under six months of age (K.V.Bailey and M.Griffin, personal communications). Only a small proportion of measured children in the surveys were under age six months, and some allowance was made for inaccuracy by recording all lengths or heights only to the nearest centimetre and weights to the nearest 100 grams. As shown in Chapter Five, the rounded weights and heights are evenly distributed and appear plausible, even for younger children.

3.7 DATA LIMITATIONS

It was pointed out in Chapter One that cross-sectional surveys such as DHS have the advantage of being easier to implement than long-term prospective studies. They can be carried out in a relatively short time using large samples which support the calculation of significant statistics. In countries where only a small proportion of children regularly attend a health facility, a survey may be the only way of obtaining information about the health of the child population as a whole. Moreover, survey methods allow the simultaneous collection of socio-economic status and demographic information which can be related to health data.

Of the possible or known limitations of these data sets, some simply restrict the analysis and interpretation of results, while others raise interesting research questions which are explored. As discussed in Chapter One, an important limitation which affects this study relates to the nature of cross-sectional surveys, which collect anthropometric measurements for only one point in time. By definition, they preclude the study of trends in the growth attainment of individuals over time. Because of the complex relationship between infection and growth attainment in children, a single measurement may be misleading at the individual level. However, as stated previously, a major objective of this study is to consider these limitations and evaluate the utility of these data sets for the study of growth attainment at the population level.

Another limitation of cross-sectional surveys, such as DHS-I, is that the study population has almost inevitably been truncated by deaths of the most severely malnourished children, which occurred prior to the survey. A related limitation for the present study is the absence of measurements and details on cause of death of dead children. Although this limits assessment of the predictive value of anthropometry, the data support some comparison of the characteristics of dead children with those who survived until the date of interview.

The absence of anthropometric data for some eligible children is an absolute limitation of the data sets. In Burundi 8 per cent, in Uganda 13 per cent and in Zimbabwe 20 per cent of children were not measured. All of the summary reports state that the most common reason for this was that the child was absent from the house at the time (BMI & IRD, 1988: 78; UMOH & IRD, 1989: 69; ZCSO & IRD, 1989: 95). In Zimbabwe only 5 per cent of those not measured were excluded because they were sick, but the percentages are not known for Burundi and Uganda. The effect of this limitation is to reduce the sample size and possibly to introduce a small bias in favour of healthy children.

A further limitation of DHS-I data sets is that they do not contain data on household or family income. As discussed in Chapter Two, family income has a crucial impact on child health, since it determines ability to command resources. However, in common with many demographic surveys, DHS-I asked few details of income, presumably because of the sensitivity of this question and because responses are likely to be unreliable. Incomes are available for the small proportion of Zimbabwe mothers in formal employment, and these data seem plausible, but, given the complex structure of household and familial relationships in this country, they are not necessarily representative of household income. For example, some households may be supported by two working parents, others may be supported by a working woman who receives income from an absentee husband or other relatives, while others may rely on a working woman who does not receive income from an absentee husband.

Ownership of household goods is often used as a proxy for income, since direct questions on earnings often produce implausible answers. Depending on the country, DHS-I generally asked about household electricity, ownership of a radio, electric or other cooker, television and refrigerator, and also ownership of a bicycle, motorcycle, motor vehicle, tractor, hand cart and boat. A limitation of using such information as a proxy for income in a national survey is that ownership tends to be related to place of residence as well as to income. Some items may not be useful to certain households and so may not be owned, even if the capacity to own is present. For example, a bicycle or tractor is of no value to mountain dwellers; electricity may not be available in some locations; and some areas may not receive television transmissions. In some locations Zimbabweans who own a scotch cart (hand cart) may be considered well off, because they can earn additional income through transport and trading, whereas in other locations they may be considered poor because they do not own a motor vehicle. Thus, in the absence of detailed information on the environment, it is unwise to use ownership of goods as a proxy for income.

Similarly, the materials from which a dwelling is constructed are not a good proxy for living standard. After visits to each of the study countries, the writer concluded that type of housing does not necessarily reflect environmental quality as it affects child survival and growth attainment. For example, it can be seen in Plate Three that in Zimbabwe the advantages of more permanent construction materials may be offset by crowding and lack of access to land for gardens.

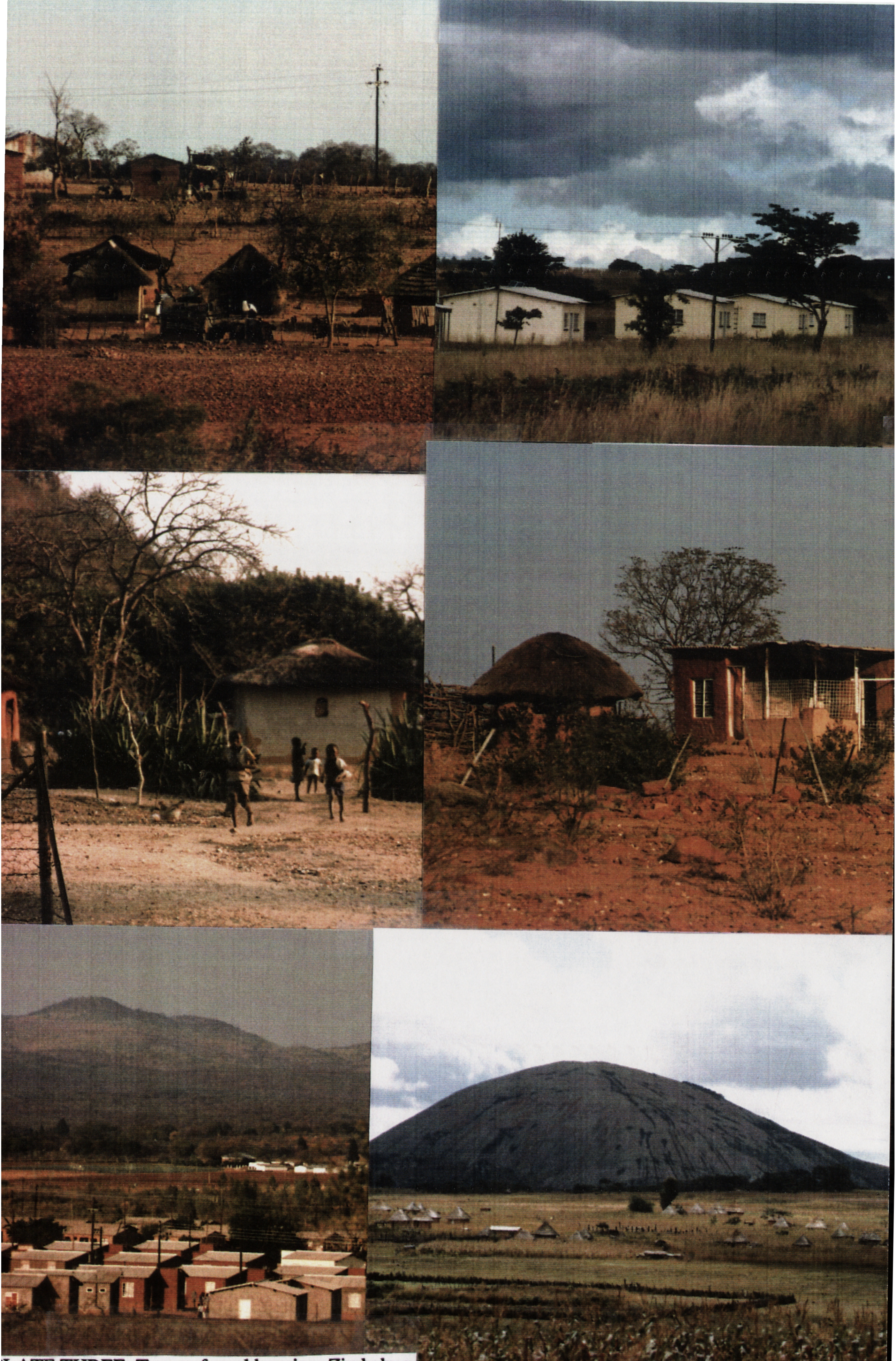


PLATE THREE: Types of rural housing, Zimbabwe

Ownership of goods and type of housing are therefore excluded from the present analysis. Electricity in household and ownership of a refrigerator are included in some models because they can have a direct effect on health and survival by facilitating safe preparation and storage of food. However, although they tend to signify wealthier households, it is not valid to assume that households which do not have these facilities necessarily have lower incomes.

One limitation which raises interesting questions is the use of maternal reporting of children's recent infections. The utility of cross-sectional surveys as sources of health data is more limited than that of prospective surveys. Cross-sectional surveys do not normally collect comprehensive medical case histories because they rely largely on respondents' recall of information about events that have occurred in the past. Recall of events such as dates and duration of episodes of illness, treatment given and food offered are often difficult to recall. An illness that has not been diagnosed by trained medical personnel may be incorrectly reported as a different illness, and respondents may have differing perceptions of the severity of illness.

In the absence of clinical diagnosis, over- or under-reporting can occur as a consequence of differing perceptions of illness. For example, better educated mothers tend to report infections that may be overlooked by uneducated mothers. This can inflate the incidence of infection among children of mothers who might be expected to provide superior care. Respondents also may have their own perception of the type of information required by interviewers. For example, Ross and Vaughan (1984: 26) reported that because interviewers chosen for a Kenyan survey were closely identified with the Kenyan Machakos project, only 0.2 per cent of respondents reported visiting a traditional healer. Yet there were 17 people in the district known to earn their living from traditional medical practices.

Van Ginneken (1991: 746) commented that the DHS emphasis is on obtaining accurate data on treatment of illness, and the questions on morbidity serve only as an introduction to this section. His comparison of DHS-I results for Zimbabwe and Kenya with those of several longitudinal studies revealed wide differences. He gave several reasons for this: first, the DHS focus on national representation compared with the small area approach of longitudinal studies; second, the DHS lack of adjustment for seasonal differences; third, DHS reliance for diagnosis on respondent's recall; fourth, the broader focus of DHS questionnaires and their different emphasis. In a later paper he noted that instruments which measure perceived morbidity measure something different from those concerned with objective morbidity, and expressed the opinion that there is no single correct way to determine morbidity (van Ginneken, 1993: 495).

There is also the question of linguistic difficulties and the quality of interviewers. Even when interviewers are familiar with local languages, surveys in multi-lingual countries run the risk that some respondents may misunderstand questions, or that some respondents may be asked a different question from others, as a result of variation between interviewers. Ware (1977) documented such problems in the Cameroon Fertility Survey, and it is almost inevitable that DHS also suffers to some extent from these effects. For example, Arnold (1991b) reported evidence of age heaping to reduce the interviewer's workload, while McMurray and Chimbwete (1991) pointed out that some questions on supplementary feeding were asked in a way which uneducated women in Zimbabwe may not have understood.

Another limitation of the DHS-I data sets used for this study is that they do not support a detailed exploration of the association of breastfeeding with child growth attainment. Although the data on breastfeeding durations are plausible, the data on consumption of other food and liquids are sketchy and sometimes inconsistent (McMurray and Chimbwete, 1991). Since most women in each country report breastfeeding for much longer than the recommended minimum of four months (Ebrahim, 1983: 54), it would be unrealistic to evaluate the effect of breastfeeding on growth attainment without detailed information on intake of other foods and liquids. Mothers were asked only what foods children had received in the 24 hours preceding the interview, and no data on frequency or quantities were recorded. It is therefore impossible to determine from these data sets whether a child was consuming sufficient food to ensure good health and optimum growth.

Similarly, it is not possible to assess the contribution of inherited genetic characteristics to the child's current growth attainment. DHS-I did not collect maternal heights and weights, although these data have since been included in some DHS-II surveys. Neither round collected paternal anthropometry. Since data on both father and mother would seem to be the minimum requirement to support any estimate of a child's genetic potential for growth, this study cannot explore this factor as a determinant of growth attainment.

Hill (1992: 91) commented that household surveys such as DHS tend to be poor at measuring recent changes in behaviour and attitudes. To this must be added another limitation, that they mix reports of past and present events. The socio-economic and environmental data in the surveys relate to the date of interview, but family circumstances may have been different when past events occurred, such as child deaths. Although income, educational attainment and occupation are possibly more stable in developing countries than in some developed countries, there is considerable population mobility which could obscure the association between child mortality and environmental factors.

The present analysis is thus constrained, and shaped to some extent, by the limitations of the data sets. These, and more specific limitations, are discussed in detail in the course of the analysis.

3.8 ORGANIZATION OF DATA SETS

As indicated above, DHS conducted interviews with women aged 15-49, and sometimes with their husbands. Information about individual children, such as sex, date of birth and immunization, is presented in the data sets as variable characteristics of the mother. The standard DHS data set format accommodates data for up to 20 births in total, and up to six children aged 0-60 months for each woman. As the subjects in most of the following analysis are children rather than mothers, copies of the data sets for each country were reconstructed to facilitate child-based computations. This was carried out on a Sun mainframe cluster with a UNIX operating environment using the software package SPSS Version 4.0 and a modified version of the procedure for reconstruction recommended by DHS (Croft and Fegan, 1991). This procedure is described in detail in McMurray and Patterson (forthcoming).

The file reconstruction process consists of creating a separate record for each child, comprising the information relating to that child plus a copy of all the information relating to that child's mother. This simplifies child-based procedures. For example, the child-based file facilitates counts of the number of children whose mothers have secondary education. On the other hand, the original data set format is more suited to counts of the number of mothers who have secondary education.

The reconstructed, child-based data sets were used for the analysis of mortality in Chapter Four. Subsets of measured children were made from the reconstructed data set for the analysis in Chapters Five and Six. The original, woman-based data sets were used for most of the analysis of family and sibling patterns in Chapter Seven.

CHAPTER FOUR: CORRELATES OF INFANT AND CHILD MORTALITY AND LOW BIRTHWEIGHT

4.1 INTRODUCTION

The survival of children under age five is determined by many factors, as discussed in Chapter One. These include the socio-economic, biological and behavioural characteristics of the mother, the quality of surroundings, the child's place within the family, and its genetic inheritance. Different factors or combinations of factors may have either a positive or negative effect on its chances of survival.

A causal model of neonatal mortality is presented in Figure 1.3, and Figure 1.4 models both mortality and growth attainment of children aged up to 60 months. Theories about the nature of the causal linkages of the various factors in the models with mortality and growth attainment were discussed in Chapter Two. It was observed that similar characteristics tend to be associated with both outcomes. However, it is clear that, since the majority of children with poor growth attainment survive, certain characteristics, or combinations of characteristics, must increase the risk of mortality.

This chapter is concerned with analysing the characteristics of dead children; that is, those who, at the time of survey, were in the 'dead' boxes in Figures 1.3 and 1.4. Chapter Six will look at the characteristics of those who survived to be in the 'alive' boxes when their mothers were interviewed. The objective of this comparison is to search for crucial differences in the characteristics associated with one outcome rather than the other.

Data on genetic factors, foetal nutrition and condition at birth are not available in the three data sets, but there are some data on ante-natal care, and birthweights are available for some Zimbabwean children. Exploration of the neonatal model will thus be confined primarily to the analysis of mortality versus survival, and neonatal death versus infant or child death. A bi-variate analysis of the characteristics of children with low birthweights is presented in Section 4.5.

The chapter begins with an overview of infant and child mortality trends and patterns in Burundi, Uganda and Zimbabwe. This is followed by a bi-variate analysis of the characteristics of all dead children in the surveys, and then an exploration of the pattern of age at death. Section 4.3.3 compares the survival probabilities of children with differing characteristics. Multi-variate analysis is used in Section 4.4 to evaluate those factors with the strongest effects.

4.2 MORTALITY PATTERNS IN BURUNDI, UGANDA AND ZIMBABWE

Ohadike (1983) commented on the difficulty of drawing conclusions about mortality patterns in African countries because of the paucity of data. He described the problems of collecting data on young children in Kenya

> *...most of whom are hidden away from enumerators on census night in order to avoid being enumerated. In fact, most African parents prefer to refer to their children rather as females than as males because of taboos and more importance attached to the latter.* (Ohadike (1983: 51).

More than a decade later, van de Walle, Pison and Sala-Diakanda (1992: 1) commented 'Africa remains largely terra incognita to the student of mortality'. They attributed this to the general absence of vital registration data, the limited utility of censuses and the tendency to conduct them only in times of peace and economic stability. They added '....the United Nations and other compilers of statistics have provided us with a false sense of coverage' and suggested that conditions could be even worse than reported.

The available recent estimates for the three countries lend support to this view. However, although it is recognised that the data are not always reliable, this study makes considerable use of reports from international agencies. In particular, UNICEF data are an important source. For many African countries the data assembled by UNICEF are virtually the only estimates of child health and survival available.

As shown in Tables 4.1, 4.2 and 4.3, mortality estimates for the years preceding the survey vary for all three countries. Although DHS was well placed to collect high quality mortality data, sample sizes are generally too small to produce estimates which can be considered representative at the regional or even at the national level.

Table 4.1: INFANT AND CHILD MORTALITY ESTIMATES: BURUNDI (deaths per 1000 births)

	IMR (1q0)	CMR (4q1)	<5MR (5q0)
SOURCE:			
Hill			
1959.0			261
1965.5			231
1969.5			223
1976.5			224
EDSB			
1972-76	100.2	137.7	224.1
1977-81	102.9	146.2	234.1
1982-1986			
Male	79.5	78.4	151.6
Female	70.5	87.4	151.7
Total	75	82.9	151.8
UNICEF			
	138		232
	127		214
	116		196
WHO	115		180

SOURCE: Hill, 1992: 14; BMI & IRD, 1989: 62; UNICEF, 1988: 6; WHO, 1990: 41-45.

In Table 4.1 it can be seen that the 1979 census of Burundi yielded an infant mortality rate (IMR) of 127 per thousand live births, and a very low life expectancy at birth of 43 years for males and 46 years for females (BMI & IRD, 1988: 4). Estimates based on EDSB suggest a slight increase in both infant and child mortality in Burundi in 1977-81 compared with 1972-76, and then a decline in 1982-86. Both the UNICEF (1988: 17) estimates for 1986 and the WHO estimate for 1990 (WHO, 1990: 43) are higher than the 1987 EDSB (BMI & IRD, 1988: 62) estimates. However, as these estimates are based on different population samples, not all of which are nationally representative, it cannot be assumed that there has been a real increase in mortality since DHS.

UNICEF (1988: 5) estimated the main causes of infant and child mortality in Burundi as measles (32 per cent) diarrhoeal disease (23 per cent), respiratory infections (16 per cent), malnutrition and anaemia (16 per cent), malaria (6 per cent) and tetanus (5 per cent). Malnutrition was said to be the underlying cause of many of these deaths.

Table 4.2: INFANT AND CHILD MORTALITY ESTIMATES: UGANDA (deaths per 1000 births)

	IMR (1q0)	CMR (4q1)	Under 5 MR (5q0)
SOURCE:			
Hill			
1957.1			245
1964.7			202
UDHS			
1973-1977	101.2	88.1	180.4
1978-1982	113.9	97	199.9
1983-1988	52.7	23.7	75.1
1978-1988			
Male	111	97.3	197.5
Female	101.7	86	178.9
WHO	105		175

SOURCE: Hill, 1992: 14; ZMOH & IRD, 1989: 54; WHO, 1990: 41-45.

As shown in Table 4.2, UDHS estimates also indicate an increase in mortality around 1980, and a decline in the period immediately before the survey. The 1969 census of Uganda reported an IMR for the country as a whole of 120 per thousand live births. In 1980 the official estimate was still 120, but Dodge and Henderson (1985: 211) reported that in 1984 the embattled province of Karamoja had an IMR of 607, and a child mortality rate (CMR) of 305, while the IMR in the Luwero triangle was 305. The chief causes of death were, in order of importance, measles and gunshot trauma. Malaria, tuberculosis and diarrhoea were also significant causes of death. In Mbale province in the same year the IMR was lower, at 95. Dodge and Henderson (1985: 212 reported that 49 and 41 per cent of deaths of children aged 1-4 years could be associated with diarrhoea and measles respectively, and 16 per cent of infant deaths could be attributed to neonatal tetanus).

Interestingly, in the DHS surveys the estimated IMRs for Uganda for the various periods were slightly above those for Burundi, but the CMRs were lower (.(BMI & IRD, 1988: 62: UMOH & IRD: 54). This is possibly a reflection of slightly lower rates of immunization against the major childhood diseases in Burundi than in Uganda.

Table 4.3: INFANT AND CHILD MORTALITY ESTIMATES: ZIMBABWE (deaths per 1000 births)

		IMR (1q0)	CMR (4q1)	Under 5 MR (5q0)
SOURCE:				
Hill				
	1957.5			162
	1964			154
	1971.1			149
	1978.4			137
ZDHS				
	1973-1977	53.6	40.2	91.6
	1978-1982	63.7	42.5	103.6
	1983-1988	52.7	23.7	75.1
	1978-1988			
	Male	64.9	30.2	93.1
	Female	49.7	32.5	80.5
1982 Census		86	39	
WHO		73		120

SOURCE: Hill, 1992: 15; ZCSO & IRD, 1989: 78; ZCSO, 1992b: 25-26; WHO, 1990: 41-45.

Mortality estimates for Zimbabwe are substantially lower, as shown in Table 4.3, but less consistent. Like EDSB and UDHS, ZDHS also suggests an increase in both infant and child mortality around 1980. As each of the three countries experienced major civil disruption at this time, such increases are plausible. The main improvement in Zimbabwe has been in childhood mortality rather than infant mortality. This almost certainly reflects higher rates of immunization as well as substantially higher living standards, a more complete network of health facilities, food supplementation programmes and better transport and communications.

On the other hand, the IMR of around 30, derived directly from the 1982 census is implausibly low, as acknowledged in the census report itself (ZCSO, 1985: 167). The 1982 census appeared to suffer from high levels of under-reporting of infant deaths. Indirect estimation produced an IMR of 83 per thousand (ZCSO, 1985: 168). This is somewhat higher than the ZDHS estimate for this period. The combined analysis, which re-evaluated data from the 1982 census and subsequent surveys, estimated the 1987 IMR as 70, higher than the ZDHS estimate of 53 for the period 1983-88 (ZCSO & IRD, 1989: 78; ZCSO, 1992b: 30). Adult life expectancy at birth was not estimated in the ZDHS, but the combined analysis produced estimates of 58 for males and 62 for females.

The World Bank (1991: 18) reported that malnutrition was the third greatest cause of infant mortality in Zimbabwe in 1985, and the leading cause in 1988. In 1987 the leading causes of child mortality were malnutrition (26 per cent), respiratory infections (12 per cent) intestinal infections (12 per cent) and meningitis (5 per cent), while measles and malaria mortality each contributed only 2 per cent of deaths (Loewenson, 1990: 59). ZNFPC (1985: 71) found that one in every four of a nationwide sample of 2,574 women aged 15-49 had lost at least one child. The mean number of dead children for rural women aged 45-49 was 1.2, compared with only 0.5 for their urban counterparts.

4.3 BI-VARIATE ANALYSIS

4.3.1 Socio-economic, demographic and environmental correlates of child mortality.

The DHS surveys include basic information about all children ever borne by women aged 15 to 49, with details of the care given to those born in the five years preceding each survey. Hence the dates of birth of the children, and the deaths reported, span some 50 or more years. Children are classified into two groups for the analysis in this chapter: children born more than five years before each survey and those born in the preceding five years, for whom additional data are available. The tables in this chapter thus relate to the mortality experience of particular birth cohorts rather than to deaths which occurred in a specific time period.

As discussed in Chapters One and Two, the present study groups region and place of residence with environmental variables, rather than with socio-economic variables. While acknowledging that groupings are primarily for convenience and do not signify rigid boundaries, it is argued that the main impact of rural or urban residence tends to be in terms of crowding and environmental sanitation. Whereas urban areas tend to have a higher concentration of educated, white-collar workers with a privileged lifestyle, many urban dwellers in the three study countries live in surroundings which may be inferior to those of some rural dwellers. Thus, although region and place of residence also interact with socio-economic factors, they are grouped with environmental factors to emphasize their association with climate, water supply, sanitation, provision of health facilities, and access to communications, employment and food.

Tables 4.4 to 4.12 compare the percentages dying in the two groups according to socio-economic, demographic and environmental characteristics[1]. Where necessary, similar categories have been combined to simplify interpretation. The p value indicates the significance of both the Pearson's chi-square and the Cramer's V statistics, and indicates whether the observed bi-variate relationship is significantly different from the expected. As a very general non-parametric statistic, the Pearson's chi-square does not distinguish ordinal from non-ordinal relationships. The values for the Pearson's chi-square are not shown, as they have no meaning other than their level of significance. The Cramer's V statistic indicates the strength of the relationship, on a scale of 0 (no relationship) to 1.00 (complete dependence). The significance level for all tables in this study was set at 0.05, that is, the 95 per cent confidence level. Values for p which are higher than 0.05 are considered as not significant.

A major feature of the bi-variate tables is that, for all three countries, the survey data clearly reflect the substantial national declines in infant and child mortality indicated in Tables 4.1, 4.2 and 4.3. Tables 4.4 to 4.12 show that in Burundi and Zimbabwe the

1 Except where stated otherwise, all computations in this study were performed with the Statistical Package for the Social Sciences (SPSS) mainframe Version 4.0 in a UNIX operating environment, or SPSS for Windows Version 5.0 on an IBM compatible microcomputer.

percentage of all children dead in the more recent time period is less than half that in the earlier period. In Uganda the figure for the more recent period is about two-thirds that for the earlier period.

As discussed above, while a reduction of political instability in all three countries may have made some contribution to this decline, the major influence has almost certainly been the expansion of child health services and immunization campaigns. The WHO-initiated EPI was introduced in all three countries after 1982 (Henderson, 1984b; UNICEF, 1985: 58,144; UNICEF, 1988: 7). Unfortunately, it is not possible to demonstrate the direct impact of immunization on child survival with these data, as DHS did not collect immunization and health information or cause of death for children born more than five years before the survey. It can only be assumed that a much smaller proportion were immunized, and that a substantial proportion died from immunizable diseases or their consequences. Tables 4.4 to 4.12 therefore compare only the socio-economic, demographic and environmental characteristics of children born in the two periods

Tables 4.4, 4.5 and 4.6 show that in all three countries most socio-economic factors have a highly significant relationship with percentage dead in the earlier period. There is a considerable reduction in some differentials in the more recent period, and fewer variables are significant, especially in Burundi and Uganda. This can be attributed in part to smaller numbers of cases in the recent period, but also to the levelling effect of immunization campaigns, as discussed by McMurray and Nzima (1991).

The direction of the relationships is generally as expected, with children of more educated parents and white-collar workers tending to experience lower mortality. Education and white-collar employment appear to have affected child survival in both periods, through better health care and higher levels of immunization. However, the low Cramer's V values indicate that the relationships for statistically significant variables are generally weak, especially in the most recent period. The highest values, for Zimbabwe, are only between 0.05 and 0.06.

Mother's education has the strongest association in Burundi in the later period, and husband's literacy and occupation in the earlier period. The curiously low proportion of deaths among Burundais children where the husband had never worked is not

Table 4.4: SOCIO-ECONOMIC CHARACTERISTICS AND PERCENTAGE DEAD AMONGST CHILDREN BORN UP TO FIVE YEARS, AND MORE THAN FIVE YEARS BEFORE THE SURVEY: BURUNDI

	Born in the preceding 5 Years				Born >5 years before survey			
	%Dead		Signif.(1)	n	%Dead		Signif. (1)	n
All children	10.0			3958	24.5			8039
Mother's education								
None	10.5			3224	25.1			6746
Primary	8.8			647	23.1			1157
Secondary +	3.0			87	10.2			135
	Cramer's V=	0.04	p=<0.05		Cramer's V=	0.05	p=<0.001	
Mother's literacy								
Cannot read	10.2			3411	25.1			7338
Reads	8.8			545	19.1			698
	Cramer's V=	0.02	n.s.		Cramer's V=	0.04	p=<0.001	
Mother working								
No	10.1			3802	24.7			7726
Yes	8.3			154	19.7			301
	Cramer's V=	0.01	n.s.		Cramer's V=	0.02	p=<0.05	
Husband's education								
None	11.1			2158	27.2			4552
Primary	9.1			1268	21.4			2456
Secondary+	8.4			180	16.3			405
	Cramer's V=	0.03	n.s.		Cramer's V=	0.08	p=<0.001	
Husband's literacy								
Reads easily	10.3			2217	26.6			4814
Cannot read	9.4			1558	20.6			2924
	Cramer's V=	0.01	n.s.		Cramer's V=	0.07	p=<0.001	
Husband's occupation								
Agriculture	10.4			3153	25.8			6527
Prof./tech./cler.	6.1			92	17.6			272
Retail, services	7.8			281	18.6			405
Manufacturing	10.7			349	21.5			672
Never worked	0.0			21	12.9			75
	Cramer's V=	0.04	n.s.		Cramer's V=	0.06	p=<0.001	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: This table, and every following table concerning Burundi, is derived from original analysis of the Burundi DHS data tape, BUIR01FL.

Table 4.5: SOCIO-ECONOMIC CHARACTERISTICS AND PERCENTAGE DEAD AMONGST CHILDREN BORN UP TO FIVE YEARS, AND MORE THAN FIVE YEARS BEFORE THE SURVEY: UGANDA

	Born in the preceding 5 years				Born >5 years before survey			
	%Dead		Signif. (1)	n	%Dead		Signif. (1)	n
All children	13.3			5121	21.7			11400
Religion								
Catholic	12.9			2250	21.9			5083
Protestant	13.7			2142	21.4			4693
Muslim	13.9			626	21.5			1383
SDA, other	9.9			103	24.6			242
	Cramer's V=	0.02	n.s		Cramer's V=	0.01	n.s.	
Mother's education								
None	13.6			2573	23.9			5998
Primary	13.2			2121	19.9			4827
Secondary +	12.4			427	12.7			576
	Cramer's V=	0.01	n.s.		Cramer's V=	0.07	p=<0.001	
Mother's literacy								
Cannot read	14.3			64	23.8			8256
Reads	11.6			36	16.5			3023
	Cramer's V=	0.04	p=<0.01		Cramer's V=	0.08	p=<0.001	
Mother working								
No	13.3			4662	22.1			10238
Yes	13.3			441	17.7			1097
	Cramer's V=	0.00	n.s.		Cramer's V=	0.03	p=<0.001	
Husband's education								
None	15.0			846	25.1			2709
Primary	12.9			2964	22.3			6248
Secondary+	12.5			1068	16.1			2171
	Cramer's V=	0.02	n.s.		Cramer's V=	0.07	p=<0.001	
Husband's literacy								
Reads easily	12.5			3521	19.9			7579
Cannot read	15.3			1383	25.5			3677
	Cramer's V=	0.04	p=<0.05		Cramer's V=	0.06	p=<0.001	
Husband's occupation								
Never worked	22.7			53	23.2			247
Prof./tech./cler.	12.0			477	17.3			1201
Retail	13.0			459	17.5			798
Agriculture	13.9			2837	24.1			6690
Services	12.5			960	18.5			1976
Manufacturing	8.0			131	19.3			354
	Cramer's V=	0.04	n.s.		Cramer's V=	0.07	p=<0.001	
Number of other wives								
0	12.5			2895	21.7			5662
1	12.8			900	23.0			2126
2+	13.3			528	25.0			1371
	Cramer's V=	0.01	n.s.		Cramer's V=	0.03	p=<0.05	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: This table, and every following table concerning Uganda, is derived from original analysis of the Uganda DHS data tape, UGIR00FL.

Table 4.6: SOCIO-ECONOMIC CHARACTERISTICS AND PERCENTAGE DEAD AMONGST CHILDREN BORN UP TO FIVE YEARS, AND MORE THAN FIVE YEARS BEFORE THE SURVEY: ZIMBABWE

	Born in the preceding 5 years				Born >5 years before survey			
	%Dead		Signif. (1)	n	%Dead		Signif.(1)	n
All children	5.7			3380	11.4			8869
Language								
Shona	6.1			2728	12.1			7327
Ndebele	3.3			573	8.0			1360
English or other	10.1			79	11.0			182
	Cramer's V=	0.05	p=<0.05		Cramer's V=	0.05	p=<0.001	
Religion								
Christian	5.1			2091	10.2			5882
Traditional	6.8			1287	13.8			2971
	Cramer's V=	0.03	p=<0.05		Cramer's V=	0.05	p=<0.001	
Mother's education								
None	8.1			628	15.1			2144
Primary	5.6			2138	10.8			5967
Secondary +	3.9			614	5.9			758
	Cramer's V=	0.06	p=<0.01		Cramer's V=	0.08	p=<0.001	
Mother's literacy								
Reads	5.0			2579	9.5			6167
Cannot read	8.1			801	15.7			2702
	Cramer's V=	0.06	p=<0.001		Cramer's V=	0.09	p=<0.001	
Mother's occupation								
Manufacturing	5.7			316	9.7			822
Prof./tech./cler.	1.5			135	4.6			383
Retail, services	6.9			231	8.2			706
Agricultural	7.8			487	13.4			1512
None stated	5.3			2216	12.0			5446
	Cramer's V=	0.05	n.s.		Cramer's V=	0.06	p=<0.001	
Husband's education								
None	7.4			367	17.1			5155
Primary	5.4			1788	10.7			1526
Secondary+	4.9			886	7.8			1390
	Cramer's V=	0.03	n.s.		Cramer's V=	0.09	p=<0.001	
Husband's literacy								
Reads easily	5.4			2966	10.6			7546
Cannot read	8.5			282	16.7			11
	Cramer's V=	0.04	p=<0.05		Cramer's V=	0.07	p=<0.001	
Husband's occupation								
Manufacturing	5.5			1173	10.7			3212
Prof./tech./cler.	4.3			416	7.5			1019
Retail, service	4.7			659	10.3			1609
Agricultural	7.0			872	14.6			2539
Never worked	11.0			82	13.3			120
	Cramer's V=	0.06	p=<0.05		Cramer's V=	0.07	p=<0.001	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: This table, and every following table concerning Zimbabwe, is derived from original analysis of the Zimbabwe DHS data tape, ZWIR01FL.

statistically significant and so must be considered an aberration due to a small number of cases.

In Uganda in the later period there is no apparent difference in survival of children of working and non-working mothers. Most women in the formal sector occupy low-level posts with low incomes. The 1989 Action for Development Survey on Women's Problems and Needs (unpublished) found that about one-third of surveyed women sold craft work and prepared food and drink, and a third sold agricultural produce (cited in UNICEF, 1989: 78). There are two possible explanations for the similarity in child survival. One is that many women who earn wages may be compelled to work because they are receiving little or no support from husbands, so may be no better off than women who stay with their children and sell produce. Another is that being left with a carer while the mother works may offset any advantages to children which come from her higher income. The contrast between Seventh Day Adventists or those following 'other' religions, who have highest mortality in the earlier period and lowest in the later period, is not significant because of the small number of cases in this group.

DHS recorded three categories of literacy for Uganda and Zimbabwe : 'reads', 'reads poorly' and 'cannot read'. For this analysis 'reads poorly' and 'cannot read' were combined, as it is considered that, in practice, reading poorly is equivalent to not reading at all. It is interesting that, for both Ugandan mothers and husbands, the difference between literacy groups is sharper than between those with and without education, and is also more significant. This greater significance of literacy than education suggests that, in this country, the actual skills learned at school may be more important for child survival than the socialisation effects of education, discussed in Chapter Two.

In Zimbabwe all socio-economic variables are significant in the earlier period, and all but mother's occupation and husband's education in the later period. As in Uganda, both mother's and husband's literacy have a more significant relationship with child mortality in the later period than education, although both are quite weak relationships. Ndebele speakers have the lowest percentage of deaths among the language groups. As they tend to concentrate in Matabeleland North and South, this could reflect environmental conditions. The lower percentage of deaths among Christians compared to those following traditional religions must partially reflect the impact of education.

Demographic characteristics are presented in Tables 4.7, 4.8 and 4.9. Preceding and succeeding birth interval are considered as three categories, less than 24 months, 24-35 months, and 36 months or more. First births which had no preceding birth interval were placed in a separate category.

It can be seen that, in addition to *single or multiple birth*, which is always expected to have a strong relationship with child survival, *preceding* and *succeeding birth interval* are most consistently highly significant in these tables, and also the related variable *number of births in the last five years*. A striking feature of the three tables is that in all three countries, in both the earlier and later periods, succeeding birth intervals of less than 24 months are associated with much higher percentages of deaths compared with intervals of 36 months or more. Where the death of the index child occurred well before the succeeding birth, this association can probably be attributed to the tendency of parents who have experienced an infant death to replace the dead child as soon as possible. However, in other cases, the conception of a second child after a short interval may have contributed to the death of the index child by promoting early weaning.

In Zimbabwe in the more recent period the percentage dead among children with short succeeding birth intervals is more than fifteen times that among those with a succeeding birth interval of three years or more. In Burundi in the more recent period the respective percentage is more than four times as great, and in Burundi in the earlier period, and Uganda in the recent period, it is twice as large. In each case the Cramer's V statistic is more than 0.10, and is as high as 0.29 for Zimbabwe in the recent period, indicating that the relationship is strong, as well as highly significant. With the single exception of Uganda in the recent period, the Cramer's V statistic for succeeding birth interval is higher than for any other variable considered in Tables 4.4 to 4.12, indicating that this variable generally has the strongest relationship with mortality. However, it is notable that the strength of this relationship tends to be less in the earlier time period, when mortality was generally higher.

The differences in the corresponding percentages for preceding birth interval are generally smaller, but nonetheless highly significant. The percentage dead among those with a preceding birth interval of less than two years is generally about twice that where the preceding interval is three years or more. In all cases, lower Cramer's

Table 4.7: DEMOGRAPHIC CHARACTERISTICS AND PERCENTAGE DEAD AMONGST CHILDREN BORN UP TO FIVE YEARS AND MORE THAN FIVE YEARS BEFORE THE SURVEY: BURUNDI

	Born in the preceding 5 years				Born >5 years before survey			
	%Dead		Signif. (1)	n	%Dead		Signif. (1)	n
All children	10.0			3958	24.5			8039
Mother's age								
< 20	14.8			144	28.4			1134
20-24	11.7			1055	25.0			2765
25-29	9.9			1187	24.0			2180
30-34	8.6			842	22.8			1267
35-39	7.7			483	22.1			553
40-44	9.2			190	17.6			140
45-49	12.6			57	0.0			0
	Cramer's V=	0.06	n.s.		Cramer's V=	0.05	p=<0.01	
Births in last 5 years								
0					27.2			2085
1	6.5			1069	23.8			2668
2	9.5			2267	22.3			2812
3+	17.9			623	30.8			475
	Cramer's V=	0.13	p=<0.001		Cramer's V=	0.06	p=<0.001	
Dead sibling								
No	8.7			2328	15.6			3023
Yes	11.8			1631	29.9			5016
	Cramer's V=	0.05	p=<0.01		Cramer's V=	0.16	p=<0.001	
Sex of child								
Male	9.9			2029	25.1			4119
Female	10.2			1930	24.0			3920
	Cramer's V=	0.00	n.s.		Cramer's V=	0.01	n.s.	
Birth Order								
1-5	10.4			2982	24.8			6858
6-10	8.5			924	23.0			1163
11+	15.6			53	33.8			18
	Cramer's V=	0.03	n.s.		Cramer's V=	0.02	n.s.	
Preceding birth interval								
First born	13.1			642	23.6			2120
< 24 montr	13.5			718	30.8			1994
24-35 mon'	9.4			1597	24.5			2483
36 months	6.3			997	17.2			1428
	Cramer's V=	0.09	p=<0.001		Cramer's V=	0.10	p=<0.001	
Succeeding birth interval								
< 24 montr	33.1			472	38.5			29.4
24-35 mon'	10.9			841	30.1			42.4
36 months	7.6			275	18.0			28.2
	Cramer's V=	0.28	p=<0.001		Cramer's V=	0.20	p=<0.001	
Multiple birth								
No	9.6			3897	24.0			7901
Yes	36.2			62	53.8			138
	Cramer's V=	0.11	p=<0.001		Cramer's V=	0.09	p=<0.001	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.4.

Table 4.8: DEMOGRAPHIC CHARACTERISTICS AND PERCENTAGE DEAD AMONGST CHILDREN BORN UP TO FIVE YEARS AND MORE THAN FIVE YEARS BEFORE THE SURVEY: UGANDA

	Born in the preceding 5 years			Born >5 years before survey		
	%Dead	Signif. (1)	n	%Dead	Signif. (1)	n
All children	13.3		5121	21.7		11400
Mother's age						
< 20	17.1		927	38.5		13
20-24	13.7		1513	26.0		445
25-29	12.3		1242	21.8		1702
30-34	11.1		751	21.0		2235
35-39	10.0		477	20.3		2503
40-44	11.3		177	21.5		2229
45-49	31.6		34	23.0		2273
	Cramer's V: 0.08	p=<0.001		Cramer's V= 0.03	p=<0.05	
Births in last 5 years						
0				24.0		3709
1	11.1		1255	20.7		3039
2	10.8		2599	19.9		3550
3+	20.6		1260	22.4		1103
	Cramer's V: 0.12	p=<0.001		Cramer's V= 0.04	p=<0.001	
Dead sibling						
No	12.8		2851	17.0		4064
Yes	13.9		2270	24.3		7336
	Cramer's V: 0.02	n.s.		Cramer's V= 0.08	p=<0.001	
Sex of child						
Male	14.8		2555	22.7		5696
Female	11.8		2566	20.7		5704
	0.04	p=<0.01		Cramer's V= 0.02	p=<0.01	
Birth order						
1-5	14.4		69.9	22.0		9041
6-10	10.4		27.4	19.9		2214
11+	13.8		2.7	26.8		146
	Cramer's V: 0.05	p=<0.001		Cramer's V= 0.02	p=<0.05	
Preceding birth interval						
First born	16.8		953	23.8		2677
< 24 months	16.2		1189	27.2		3419
24-35 months	11.0		1862	18.1		3684
36 months +	10.6		1109	14.2		1595
	Cramer's V: 0.08	p=<0.001		Cramer's V= 0.11	p=<0.001	
Succeeding birth interval						
< 24 months	26.7		975	27.5		4268
24-35 months	12.8		914	17.6		3967
36 months +	13.5		257	18.1		2441
	Cramer's V: 0.17	p=<0.001		Cramer's V= 0.12	p=<0.001	
Multiple birth						
No	12.6		4940	21.1		11099
Yes	31.5		181	42.2		301
	Cramer's V: 0.10	p=<0.001		Cramer's V= 0.08	p=<0.001	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.5.

Table 4.9: DEMOGRAPHIC CHARACTERISTICS AND PERCENTAGE DEAD AMONGST CHILDREN BORN UP TO FIVE YEARS AND MORE THAN FIVE YEARS BEFORE THE SURVEY: ZIMBABWE

	Born in the preceding 5 years			Born >5 years before survey		
	%Dead	Signif. (1)	n	%Dead	Signif. (1)	n
All children	5.7		3380	11.4		8869
Mother's age						
15-19	6.8		424	13.4		2037
20-24	4.5		976	11.8		3030
25-29	5.6		826	9.8		2051
30-34	5.9		626	9.7		1142
35-39	6.8		368	11.0		471
40-44	7.4		121	9.2		130
45-49	10.3		39	50.0		8
	Cramer's V=	0.04 n.s.		Cramer's V=	0.06 p=<0.001	
Births in last 5 years						
0				11.3		3253
1	3.5		1299	10.8		3160
2	4.9		1661	12.0		2106
3+	16.2		408	14.9		350
	Cramer's V=	0.17 p=<0.001		Cramer's V=	0.03 n.s.	
Dead sibling						
No	4.6		2493	8.6		5225
Yes	8.9		887	15.5		3644
	Cramer's V=	0.08 p=<0.001		Cramer's V=	0.11 p=<0.001	
Sex of child						
Male	5.8		1690	12.6		4528
Female	5.7		1690	10.2		4341
	Cramer's V=	0.00 n.s.		Cramer's V=	0.04 p=<0.001	
Birth order						
1-5	5.2		2535	11.3		7390
6-10	7.2		794	11.6		1412
11+	11.8		51	20.9		67
	Cramer's V=	0.05 p=<0.05		Cramer's V=	0.03 p=<0.05	
Preceding birth interval						
First born	5.1		683	11.8		2264
< 24 months	9.1		497	16.4		1970
24-35 month	5.0		1241	9.9		2953
36 months +	5.3		955	7.2		1653
	Cramer's V=	0.06 p=<0.01		Cramer's V=	0.10 p=<0.001	
Succeeding birth interval						
< 24 months	23.0		305	21.4		2157
24-35 month	5.0		597	9.1		3580
36 months +	1.5		200	6.8		2388
	Cramer's V=	0.29 p=<0.001		Cramer's V=	0.18 p=<0.001	
Multiple birth						
No	5.4		3250	11.0		8535
Yes	13.8		130	21.0		334
	Cramer's V=	0.07 p=<0.001		Cramer's V=	0.06 p=<0.001	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.6.

V statistics indicate a weaker relationship of mortality with preceding birth interval than with succeeding birth interval. As in the case of succeeding birth interval, a short preceding birth interval could indicate that the parents are hastening to replace a dead child. However, since the index child would not be subject to competition from a dead preceding sibling, preceding birth interval is a truer representation of the deleterious effects of short birth intervals *per se* than is succeeding birth interval.

Some 40 per cent of all succeeding birth intervals in Uganda are less than two years in duration in both time periods, around 30 per cent in Burundi and just below 30 per cent in Zimbabwe. The percentage of preceding birth intervals which are less than 24 months ranges from 15 to 30 per cent. It is therefore evident that, even allowing for the replacement effect in some cases, short preceding and succeeding birth intervals may be making a very substantial contribution to child mortality in all three countries.

The highly significant association of three or more births, in the five years preceding the survey, with a much higher percentage of deaths than one or two births, also is a reflection of the effect of birth interval. As in the case of birth interval, the Cramer's V statistics indicate a weaker association in the earlier period, when overall mortality was higher.

As would be expected, mothers who appear only in the earlier period, because they had no births in the five years preceding the survey, had a higher percentage of dead children in most categories. This is because their births occurred in the earlier time period, when mortality was higher. Mothers aged 45-49 years tend to have the highest percentage of deaths overall, and mortality also tends to be higher for higher birth orders.

Differentials according to environmental characteristics are presented in Tables 4.10, 4.11 and 4.12. Generally they are less consistent than those for demographic variables. Although many are significant in the earlier time period, few remain significant in the later period. It is interesting that the strongest relationship in each country is for number of children under five years in the household. Clearly, smaller numbers of surviving children are associated with higher death rates. This reflects higher percentages of deaths among mothers with three or more births in the preceding five years, as shown in Tables 4.7, 4.8 and 4.9. Presumably, the few children whose

Table 4.10: ENVIRONMENTAL CHARACTERISTICS AND PERCENTAGE DEAD AMONGST CHILDREN BORN UP TO FIVE YEARS AND MORE THAN FIVE YEARS BEFORE THE SURVEY: BURUNDI

	Born in the preceding 5 years			Born >5 years before survey		
	%Dead	Signif. (1)	n	%Dead	Signif. (1)	n
All children	10.0		3959	24.5		8039
Region						
Central Plateau	9.5		2158	24.1		4301
Mumirwa	9.1		456	21.4		995
Mugamba	7.8		383	21.0		771
Imbo	18.0		320	24.9		629
Depressions	9.7		642	30.2		1343
	Cramer's V: 0.08	p=<0.001		Cramer's V= 0.07	p=<0.001	
Place of residence						
Rural	9.9		3826	24.8		7735
Urban	13.2		133	17.4		304
	Cramer's V: 0.02	n.s.		Cramer's V= 0.03	p=<0.01	
Drinking water source						
Well or bore	10.3		2199	23.8		4320
Piped	2.8		43	6.9		76
Surface,other	9.8		1716	25.8		3643
	Cramer's V: 0.03	n.s.		Cramer's V= 0.05	p=<0.001	
Time to water source						
On premises	3.1		46	8.4		85
1-5 mins	14.4		265	25.0		606
5-10 mins	9.2		491	22.9		1087
11-30 mins	9.6		1978	24.7		4118
>30 mins	10.4		1179	25.6		2142
	Cramer's V: 0.05	n.s.		Cramer's V= 0.04	p=<0.01	
Electricity						
No	10.1		3909	24.7		7956
Yes	1.4		50	8.1		84
	Cramer's V: 0.03	p=<0.05		Cramer's V= 0.04	p=<0.001	
Has refrigerator						
No	10.1		3941	24.6		8000
Yes	2.7		17	6.1		39
	Cramer's V: 0.02	n.s.		Cramer's V= 0.03	p=<0.01	
Cake of soap on premises						
Yes	10.0		3254	24.5		6559
No	9.9		690	25.0		1462
	Cramer's V: 0.00	n.s.		Cramer's V= 0.01	n.s.	
Toilet facility						
None	15.6		185	32.3		413
Flush	1.2		39	9.2		77
Pit	9.8		3734	24.3		413
	Cramer's V: 0.05	p=<0.01		Cramer's V= 0.05	p=<0.001	
No. in household						
1-6	13.2		2074	33.0		3388
7-10	6.3		1391	19.4		3661
11+	7.1		493	14.5		990
	Cramer's V: 0.11	p=<0.001		Cramer's V= 0.17	p=<0.001	
No. children aged up to 5yrs						
1	22.3		1165	27.4		4234
2	5.7		1964	22.2		2799
3+	3.0		831	18.9		1007
	Cramer's V: 0.27	p=<0.001		Cramer's V= 0.07	p=<0.001	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.4.

Table 4.11: ENVIRONMENTAL CHARACTERISTICS AND PERCENTAGE DEAD AMONGST CHILDREN BORN UP TO FIVE YEARS AND MORE THAN FIVE YEARS BEFORE THE SURVEY: UGANDA

	Born in the preceding 5 years				Born >5 years before survey			
	%Dead		Signif. (1)	n	%Dead		Signif. (1)	n
All children	13.3			5121	21.7			11400
Region								
South West	11.1			1529	20.4			3307
East	14.1			1421	24.7			3329
Central	14.4			1290	19.6			2895
West	15.2			325	22.8			698
West Nile	12.2			283	26.3			680
Kampala	14.8			273	14.1			490
	Cramer's V=	0.05	n.s.		Cramer's V=	0.07	p=<0.001	
Place of residence								
Urban	13.3			4623	22.2			10484
Rural	12.7			499	15.9			916
	Cramer's V=	0.01	n.s.		Cramer's V=	0.04	p=<0.001	
Electricity to house								
No	13.3			4801	22.1			10904
Yes	12.9			321	12.7			497
	Cramer's V=	0.00	n.s.		Cramer's V=	0.05	p=<0.001	
Has refrigerator								
No	13.3			5078	21.8			11310
Yes	9.3			42	11.4			84
	Cramer's V=	0.01	n.s.		Cramer's V=	0.02	p=<0.05	
Drinking water source								
Well or bore	13.3			2461	22.5			5688
Piped to res.	9.6			41	6.2			91
Outside tap	12.2			321	20.5			596
Surface,othe	13.5			2298	21.1			5025
	Cramer's V=	0.01	n.s.		Cramer's V=	0.04	p=<0.001	
Distance to water source								
< 500m	13.9			1748	20.2			3728
.5-1 km	12.7			1550	21.3			3570
1 - 1.5 km	13.6			1133	22.6			2474
1.5 - 4.5 km	12.2			642	24.4			1521
4.5 km +	16.9			49	26.5			106
	Cramer's V=	0.02	n.s.		Cramer's V=	0.04	p=<0.01	
Toilet facility								
None	14.7			843	25.9			2021
Flush	8.6			137	10.5			225
Latrine, pit	13.1			4142	21.0			9150
	Cramer's V=	0.03	n.s.		Cramer's V=	0.06	p=<0.001	
Soap on premises								
Yes	13.5			4376	21.0			9199
No	11.9			743	24.6			2169
	Cramer's V=	0.02	n.s.		Cramer's V=	0.03	p=<0.001	
No. in household								
1-6	15.9			2701	27.6			5060
7-10	10.7			1828	17.4			4690
10 +	9.2			592	15.7			1650
	Cramer's V=	0.08	p=<0.001		Cramer's V=	0.13	p=<0.001	
No. children aged up to 5yrs								
1	23.8			1462	24.0			5470
2	10.7			1901	20.9			3184
3+	7.2			1759	18.0			2747
	Cramer's V=	0.20	p=<0.001		Cramer's V=	0.06	p=<0.001	

(1) Significance of chi-square and Cramer's V statistics
n.s. signifies p=>0.05

SOURCE: As for Table 4.5.

Table 4.12: ENVIRONMENTAL CHARACTERISTICS AND PERCENTAGE DEAD AMONGST CHILDREN BORN UP TO FIVE YEARS AND MORE THAN FIVE YEARS BEFORE THE SURVEY: ZIMBABWE

	Born in the preceding 5 years			Born >5 years before survey		
	%Dead	Signif. (1)	n	%Dead	Signif. (1)	n
All children	5.7		3380	11.4		8869
Region						
Manicaland	7.5		466	14.9		1320
Mashonaland E.	5.5		454	12.4		1248
Mashonaland W.	7.1		411	12.3		1220
Mashonaland C.	9.2		174	9.7		390
Matableleland N.	2.6		232	8.7		587
Matabeleland S.	4.9		508	11.8		1320
Midlands	5.8		415	11.0		1027
Masvingo	3.6		223	7.4		581
Harare/Chitungwiza	2.1		239	6.0		547
Bulawayo	8.1		258	12.1		629
	Cramer's V=	0.08 p=<0.01		Cramer's V=	0.07 p=<0.001	
Place of residence						
Rural	6.4		2499	12.8		6646
Urban	3.9		881	7.3		2223
	Cramer's V=	0.05 p=<0.01		Cramer's V=	0.08 p=<0.001	
Type of land holding						
Communal	6.3		1851	12.3		5078
Large commercial	6.7		507	14.2		1241
Urban	3.9		881	7.3		2223
Resettlement	8.0		112	13.6		243
Small commercial	0.0		29	21.4		84
	Cramer's V=	0.06 p=<0.05		Cramer's V=	0.08 p=<0.001	
Drinking water source						
Well or bore	6.4		1621	12.9		4445
Piped to house	4.6		797	6.8		1945
Outside tap	4.9		534	12.9		1291
Surface,other	6.5		428	12.0		1188
	Cramer's V=	0.04 n.s.		Cramer's V=	0.08 p=<0.001	
Distance to drinking water						
On premises	4.4		1096	8.3		2739
Up to 30m	6.4		376	12.1		973
31-100 m	6.4		373	12.4		1087
101m -1 km	6.5		1229	12.9		3339
> 1 kilometre	5.9		306	13.8		731
	Cramer's V=	0.04 n.s.		Cramer's V=	0.07 p=<0.001	
Electricity						
No	6.1		2552	12.7		6875
Yes	4.7		828	6.8		1994
	Cramer's V=	0.03 n.s.		Cramer's V=	0.08 p=<0.001	
Has refrigerator						
No	5.9		3047	12.1		8011
Yes	4.2		332	4.9		857
	Cramer's V=	0.02 n.s.		Cramer's V=	0.07 p=<0.001	
Toilet facility						
None	6.4		1376	13.7		3484
Flush	4.1		951	7.3		2308
Blair toilet	5.3		570	10.9		1754
Pit latrine	7.7		482	13.4		1321
	Cramer's V=	0.05 n.s.		Cramer's V=	0.08 p=<0.001	
No. in household						
1-6	7.2		1495	12.5		3325
7-10	4.9		1375	11.0		4205
11+	3.9		510	9.8		1339
	Cramer's V=	0.06 p=<0.01		Cramer's V=	0.03 p=<0.05	
No. children aged up to 5yrs						
1	10.5		1100	11.2		4654
2	3.8		1431	11.9		2775
3+	2.8		849	11.1		1440
	Cramer's V=	0.14 p=<0.001		Cramer's V=	0.01 n.s.	

(1) Significance of chi-square and Cramer's V statistics
n.s. signifies p=>0.05

SOURCE: As for Table 4.6.

mothers had three or more surviving children aged five years or less had a high risk of dying in the future.

A similar pattern of higher percentages of deaths in smaller households also can be seen in these tables. However, while small household size may be a consequence of higher mortality, substantially lower percentages of deaths in households of 11 or more probably reflect superior child care where there are more carers.

A surprising finding for Burundi is that, in the later period, higher percentages of deaths occurred in Imbo, the province where the capital, Bujumbura, is located. The higher percentage of deaths in urban areas as a whole than in rural areas, is not statistically significant because of the small number of cases. Nonetheless, the urban based services (electricity, having a refrigerator, water on premises and flush toilet) produce noticeably lower mortality rates, with electricity significant at the 5 per cent level. This apparent inconsistency can be explained by the existence of two crowded shanty towns, Buyenzi and Bwiza, on the outskirts of Bujumbura. Residents of these settlements do not enjoy the health advantages of the elite urban dwellers of Bujumbura, and infant mortality and malnutrition levels are high (UNICEF, 1988: 14). Moreover, the prevalence of chloroquine-resistant malaria is also highest in Imbo province (O'Toole and Wright, 1991: 260).

For Uganda also there is no significant difference in the percentages dead among urban and rural dwellers in the later period. Unfortunately, distance to water source was pre-coded in the UDHS data set, with the lowest category less than one-quarter of a mile (440 metres). The advantage of having water on the premises is therefore not apparent from this variable, while the small number of cases with piped water precludes a significant difference for drinking water source. Nor are there significant differences between regions.

Although urban areas as a whole in Zimbabwe have a significantly lower percentage of dead children in both periods, there is marked variation between them. Harare / Chitungwiza have a much smaller percentage dead than Bulawayo, in both the early and later period. This is consistent with a higher living standard and more wage employment opportunities for black Zimbabweans in Harare.

Throughout Tables 4.4 to 4.12 the generally lower significance of socio-economic and environmental variables in the more recent period can be attributed, in part, to smaller sample sizes and hence fewer deaths. However, the importance of demographic variables persists in both time periods, in all three countries, irrespective of sample size. This is consistent with the main cause of the reduction in mortality being the expansion of immunization and health care. As discussed in Chapter Two, immunization and use of ORT can offset the effects of disadvantageous socio-economic and environmental conditions. On the other hand, it is more difficult to offset the effects of demographic factors on mortality.

It must be remembered that one limitation of these tabulations is that family circumstances could have changed over time, as discussed in Section 3.7. If so, reports of current conditions, such as source of drinking water, distance to drinking water source, electricity in household and mother working, might not be relevant to deaths that occurred many years before the survey. It is thus interesting to observe that, within each country, the patterns are reasonably similar in both time periods, with the same categories tending to have the highest percentage of deaths, although the levels and significance may vary. This reinforces the view that the main factor associated with the reduction in child mortality has been the expansion of immunization and health programmes, which tend to reach across all communities.

4.3.2 Age at death

The pattern of age at death in the three countries also suggests that the main factor in mortality decline has been the expansion of immunization and health care. As discussed in Chapter Two, neonatal deaths are most often caused by biological factors, including maternal factors. On the other hand, deaths that occur at later ages are more likely to be affected by socio-economic and environmental factors, inadequate child care or competition with siblings. Although expansion of ante-natal anti-tetanus immunization brings a dramatic reduction in death from neonatal tetanus, it is more difficult to prevent other causes of neonatal mortality. Gestational growth retardation, congenital defects, complications during delivery, and maternal depletion can be difficult, or even impossible, to prevent, even with state-of-the-art medical technology. Hence the proportion of deaths due to these factors increases as mortality up to age five declines. It would therefore be expected that better health care and extended immunization coverage in the study countries would manifest as a shift in the distribution of age at death towards a higher percentage of neonatal deaths.

Tables 4.13, 4.14 and 4.15 compare the age distribution of children who died in the five years preceding the surveys with those who died more than five years previously. Age at death was classified as neonatal (0 months), post-neonatal (1-11 months), second year (12-23 months) or childhood (over 24 months). Deaths in the second year were classified separately, because this is the age at which weaning normally occurs in the studied countries, and hence the age when children are most vulnerable to nutritional deprivation. All variables in Tables 4.4 to 4.12 were cross-tabulated with age at death. Only those which proved significant at the 95 per cent confidence level or higher, or which were considered as essential characteristics, were included in Tables 4.13, 4.14 and 4.15. Among the variables dropped because they were insignificant in both periods were those relating to water, sanitation and household crowding.

These tables must be interpreted in the light of the preceding tables, which show that the percentages dying have halved in Burundi and Zimbabwe and reduced by one-third in Uganda. The distribution for all children is shown at the top of each table, followed by the distribution according to selected characteristics.

In all three countries, deaths in infancy (that is, ages 0-11 months) accounted for more than 45 per cent of all deaths of children who died more than five years before the surveys, and this increased to more than 60 per cent of deaths in the five years preceding the surveys. In Zimbabwe infant deaths accounted for 80 per cent of child deaths in the five years preceding the survey. It should be noted that this statistic is subject to censoring in the later period, because not all children have been exposed to the risk of death for equal durations. However, the magnitude of the difference suggests that, even allowing for censoring, there has been a shift towards a relatively greater percentage of infant deaths and fewer deaths of young children.

This pattern is consistent with the expected shift towards more deaths from maternal and biological causes when improvements in health care and immunization occur. It is notable that the shift has been greatest in Zimbabwe, which has the highest immunization coverage and the best facilities for child health care among the three countries. In that country neonatal deaths accounted for 45 per cent of all child deaths

Table 4.13: SELECTED CHARACTERISTICS AND AGE DISTRIBUTION OF CHILDREN WHO DIED UP TO FIVE YEARS AND MORE THAN FIVE YEARS BEFORE THE SURVEY: BURUNDI (per cent)

	Died in preceding 5 yrs					Died > 5 yrs before survey				
Age at death (mths)	0	1-11	12-23	24+	n	0	1-11	12-23	24+	n
All dead children	34.6	32.8	14.6	18.0	397	20.2	25.1	14.7	39.9	1777
Sex of child										
Male	35.9	31.8	14.7	17.7	201	23.0	26.7	14.9	34.4	938
Female	33.3	33.7	14.5	18.4	196	17.2	23.4	14.6	44.8	839
			n.s.					p=<0.001		
Type of birth										
Single	33.4	33.4	14.5	18.7	374	19.0	25.1	15.1	40.8	1706
Multiple	54.6	22.7	16.5	6.2	22	49.7	26.6	5.2	18.5	71
			n.s.					p=<0.001		
Mother's age										
< 30 yrs	35.9	36.5	12.0	15.6	262	20.0	22.8	14.7	42.5	1406
30 yrs +	32.2	25.4	19.6	22.8	134	21.3	33.9	14.8	30.0	370
			p=<0.05					p=<0.001		
Birth order										
1-5	33.4	35.1	12.0	19.5	309	19.8	24.6	14.7	41.0	1538
6-10	37.3	23.9	24.8	14.0	79	23.7	27.8	15.1	33.3	235
11+	55.5	30.6	13.9	0.0	8	0.0	62.3	31.2	6.5	4
			p=<0.05					n.s.		
Preceding birth interval										
First born	29.9	32.7	13.4	23.9	140	18.2	26.2	15.5	40.0	529
< 24 months	39.9	36.6	11.2	12.4	97	24.4	27.7	12.7	35.2	553
24-35 months	43.2	31.2	13.4	12.2	86	21.5	20.7	14.8	43.0	468
36 months +	26.6	29.5	22.8	21.2	73	12.1	25.5	17.7	44.7	226
			n.s.					p=<0.01		
Suceeding birth interval										
No succeeding birth	36.9	36.8	13.1	13.1	128	31.8	22.0	22.0	24.2	61
< 24 months	41.6	31.7	12.5	14.1	156	26.9	28.8	13.6	30.8	807
24-35 months	21.4	34.5	18.8	25.4	86	14.2	24.3	14.5	47.0	547
36 months +	25.8	13.8	19.9	40.5	27	12.5	18.7	16.6	52.1	361
			p=<0.01					p=<0.001		
Region										
Central Plateau	35.8	30.7	14.5	19.0	206	20.0	24.4	15.5	40.1	937
Mumirwa	30.6	44.4	19.4	5.6	41	24.2	22.4	12.7	40.6	190
Mugamba	42.3	26.9	3.8	26.9	30	19.2	23.2	16.8	40.8	144
Imbo	21.0	40.0	16.6	22.4	58	22.5	27.1	19.2	31.2	138
Depressions	42.6	27.8	14.8	14.8	62	18.4	28.3	11.5	41.7	369
			p=<0.05					n.s.		
Place of residence										
Rural	35.2	32.1	14.2	18.5	379	20.3	24.9	14.7	40.1	1729
Urban	23.3	46.6	21.9	8.2	17	17.1	32.7	17.1	33.2	48
			n.s.					n.s.		
Mother's education										
None	33.8	33.0	14.0	19.2	337	20.3	24.8	14.0	40.9	1521
Primary	40.1	32.6	15.5	11.8	57	20.1	26.9	19.5	33.5	243
Secondary+	18.5	9.3	72.2	0.0	3	19.7	27.7	15.7	36.9	12
			n.s.					n.s.		
Husband's education										
None	36.9	29.9	14.3	18.9	239	20.4	24.7	14.5	40.4	1110
Primary	29.8	35.2	19.0	16.0	115	20.3	27.2	16.7	35.9	476
Secondary+	38.3	35.4	7.9	18.4	15	18.2	24.0	12.4	45.4	64
			n.s.					n.s.		
Husband's occupation										
Agriculture	33.5	33.0	14.6	16.9	327	19.5	25.2	14.7	40.5	1511
Prof./tech./cler.	45.3	21.4	8.6	24.8	6	26.1	25.8	12.2	35.9	48
Retail, services	25.2	28.5	23.3	23.0	22	24.8	25.5	16.9	32.7	70
Manufacturing	34.1	31.3	11.8	22.8	37	21.7	25.9	14.5	37.9	129
Never worked	0.0	0.0	0.0	0.0	0	27.0	13.5	0.0	59.6	9
			n.s.					n.s.		

NOTE: n.s. signifies p= >0 .05

SOURCE: As for Table 4.4.

Table 4.14: SELECTED CHARACTERISTICS AND AGE AT DEATH OF CHILDREN WHO DIED UP TO FIVE YEARS AND MORE THAN FIVE YEARS BEFORE THE SURVEY: UGANDA (per cent)

	Died in preceding 5 yrs					Died > 5 yrs before survey				
Age at death (mths)	0	1-11	12-23	24+	n	0	1-11	12-23	24+	n
All dead children	32.0	37.1	18.4	12.5	680	26.5	27.5	13.7	32.3	2273
Sex of child										
Male	31.9	36.4	18.7	13.0	378	28.2	26.3	14.1	31.5	1202
Female	32.2	38.0	17.9	11.9	302	24.6	28.9	13.3	33.2	1071
		n.s.					n.s.			
Type of birth										
Single	29.5	38.2	19.0	13.3	623	24.6	27.3	14.4	33.8	2147
Multiple	59.1	25.5	11.5	3.9	57	59.1	30.6	3.1	7.2	126
		p=<0.001					p=<0.001			
Mother's age										
< 30 yrs	30.9	37.2	18.7	13.2	518	25.7	26.9	13.9	33.5	1945
30 yrs +	35.5	36.8	17.3	10.4	162	31.0	30.9	13.0	25.1	328
		n.s.					p=<0.05			
Birth order										
1-5	29.8	37.3	20.2	12.8	515	24.9	27.4	13.9	33.8	1836
6-10	38.0	38.6	13.2	10.2	146	30.6	27.5	14.0	28.0	403
11+	47.1	20.6	8.8	23.6	19	63.1	31.1	1.7	4.1	33
		n.s.					p=<0.001			
Preceding birth interval										
First born	29.4	34.1	24.6	12.0	161	29.7	26.5	14.3	29.5	613
< 24 months	33.4	40.9	17.6	8.0	193	27.0	29.3	13.5	30.2	864
24-35 months	30.9	36.3	13.1	19.7	195	22.7	24.9	13.8	38.6	581
36 months +	34.8	36.5	19.6	9.1	130	25.3	30.2	12.8	31.7	215
		p=<0.05					p=<0.05			
Suceeding birth interval										
No succeeding birth	35.8	41.3	15.5	7.4	269	38.0	25.6	12.3	24.1	145
< 24 months	36.5	41.2	15.6	6.6	245	31.4	30.3	9.8	28.6	1001
24-35 months	20.2	22.9	27.3	29.6	131	21.7	24.2	18.9	35.3	697
36 months +	15.7	29.7	25.8	28.8	35	18.9	27.1	15.1	38.8	430
		p=<0.001					p=<0.001			
Region										
South West	32.9	41.3	17.3	8.6	169	24.6	26.9	14.5	34.1	617
East	30.9	36.5	18.9	13.7	200	25.2	31.5	12.6	30.8	776
Central	32.5	31.2	19.4	16.9	186	28.2	21.6	15.8	34.3	500
West	33.3	36.7	20.0	10.0	49	40.6	18.8	9.4	31.3	158
West Nile	38.1	42.9	14.3	4.8	35	18.4	37.8	14.3	29.6	161
Kampala	25.0	45.8	16.7	12.5	40	31.8	27.1	14.0	27.1	60
		n.s.					p=<0.001			
Place of residence										
Rural	32.5	36.7	18.3	12.5	616	26.1	27.5	13.8	32.6	2140
Urban	27.4	41.6	18.6	12.4	64	32.5	27.4	12.2	27.8	133
		n.s.					n.s.			
Mother's education										
None	27.9	39.1	20.0	13.0	288	23.4	30.0	12.9	33.7	1336
Primary	33.7	37.8	15.6	12.9	339	30.9	23.5	15.3	30.7	872
Secondary+	49.5	20.6	22.4	7.4	53	30.0	30.7	9.5	29.9	65
		p=<0.05					p=<0.001			
Husband's education										
None	28.3	41.2	20.8	9.8	127	21.1	31.2	12.3	35.4	633
Primary	33.6	37.4	16.8	12.2	383	27.0	26.4	15.5	31.1	1284
Secondary+	29.8	34.3	17.3	18.6	134	33.8	23.2	10.2	32.8	314
		n.s.					p=<0.001			
Husband's occupation										
Agriculture	31.4	38.7	16.5	13.4	395	24.7	27.1	13.7	34.5	1489
Prof./tech./cler.	40.5	34.3	12.6	12.6	57	29.4	28.6	10.7	31.3	187
Retail, services	31.5	38.2	17.3	13.0	120	29.5	30.1	14.4	26.1	341
Manufacturing	5.4	49.8	39.5	5.4	11	30.0	21.4	17.6	31.0	60
Student	33.4	31.4	22.0	13.2	65	30.8	25.7	17.6	25.9	123
Never worked	8.5	45.7	45.7	0.0	7	23.5	34.0	10.5	32.0	55
		n.s.					n.s.			

NOTE: n.s. signifies p= >0 .05

SOURCE: As for Table 4.5.

Table 4.15: SELECTED CHARACTERISTICS AND AGE AT DEATH OF CHILDREN WHO DIED UP TO FIVE YEARS AND MORE THAN FIVE YEARS BEFORE THE SURVEY: ZIMBABWE (per cent)

	Died in preceding 5 yrs					Died > 5 yrs before survey				
Age at death (mths)	0	1-11	12-23	24+	n	0	1-11	12-23	24+	n
All dead children	45.4	34.0	14.9	5.7	194	29.5	27.1	17.0	26.3	1010
Sex of child										
Male	46.9	35.7	13.3	4.1	98	32.3	27.2	17.2	23.3	570
Female	43.8	32.3	16.7	7.3	96	25.9	27.0	16.8	30.2	440
		n.s.					p= <0.05			
Type of birth										
Single	43.2	34.7	15.9	6.3	176	28.4	26.7	17.7	27.2	940
Multiple	66.7	27.8	5.6	0.0	18	44.3	32.9	8.6	14.3	70
		n.s.					p=<0.01			
Mother's age										
< 30 yrs	40.3	36.1	16.8	6.7	119	27.9	26.7	18.2	27.2	835
30 yrs +	53.3	30.7	12.0	4.0	75	37.1	29.1	11.4	22.3	175
		n.s.					p=<0.05			
Birth order										
1-5	39.7	35.1	18.3	6.9	131	28.0	26.8	18.0	27.2	832
6-10	59.6	28.1	8.8	3.5	57	34.8	29.9	12.2	23.2	164
11+	33.3	66.7	0.0	0.0	6	57.1	14.3	14.3	14.3	14
		n.s.					n.s.			
Preceding birth interval										
First born	41.7	38.9	13.9	5.6	36	30.0	28.2	15.5	24.6	277
< 24 months	46.7	31.1	17.8	4.4	45	32.0	26.7	17.1	24.2	322
24-35 months	45.0	33.3	13.3	8.3	60	25.2	27.7	16.5	30.6	278
36 months +	47.2	34.0	15.1	3.8	53	31.6	24.8	21.1	22.6	133
		n.s.					n.s.			
Succeeding birth interval										
No succeeding birth	48.4	36.3	9.9	5.5	91	30.2	33.3	19.0	17.5	63
< 24 months	51.4	30.0	12.9	5.7	70	36.7	30.4	14.1	18.7	460
24-35 months	25.0	35.7	35.7	3.6	28	23.7	23.3	21.0	32.0	300
36 months +	20.0	40.0	20.0	20.0	5	20.9	23.0	17.1	39.0	187
		n.s.					p=<0.001			
Region										
Manicaland	34.3	31.4	25.7	8.6	35	24.4	26.9	21.8	26.9	197
Mashonaland East	40.0	36.0	20.0	4.0	25	22.6	23.9	21.3	32.3	155
Mashonaland West	37.9	48.3	10.3	3.4	29	43.9	23.0	11.5	21.6	148
Mashonaland Central	38.1	33.3	14.3	14.3	21	25	31.6	7.9	35.5	76
Matabeleland North	43.8	37.5	12.5	6.3	16	23.7	31.6	15.8	28.9	38
Matabeleland South	33.3	33.3	33.3	0.0	6	41.2	29.4	13.7	15.7	51
Midlands	60.0	28.0	8.0	4.0	25	26.9	32.7	16.7	23.7	156
Masvingo	62.5	25.0	8.3	4.2	24	24.8	28.3	22.1	24.8	113
Harare/Chitungwiza	62.5	37.5	0.0	0.0	8	41.9	20.9	9.3	27.9	43
Bulawayo	60.0	20.0	20.0	0.0	5	39.4	21.2	15.2	24.2	33
		n.s.					p=<0.01			
Place of residence										
Rural	44.4	33.8	15.0	6.9	160	28.8	28.2	17.7	25.4	848
Urban	50.0	35.3	14.7	0.0	34	33.3	21.6	13.6	31.5	162
		n.s.					n.s.			
Mother's education										
None	37.3	43.1	11.8	7.8	51	26.5	27.5	14.2	31.8	324
Primary	47.9	28.6	17.6	5.9	119	30.3	26.7	18.7	24.3	641
Secondary	50.0	41.7	8.3	0.0	51	40.0	31.1	13.3	15.6	45
		n.s.					p=<0.05			
Husband's education										
None	37.0	40.7	11.1	11.1	27	24.9	28.7	17.3	29.1	237
Primary	46.4	27.8	19.6	6.2	97	32.1	26.8	16.8	24.4	549
Secondary	53.5	39.5	4.7	2.3	43	33.9	23.7	18.6	23.7	118
		n.s.					n.s.			
Husband's occupation										
Manufacturing	55.6	33.3	11.1	0.0	9	0.0	18.8	25.0	56.3	16
Prof./tech./cler.	44.4	33.3	22.2	0.0	9	38.6	25.0	6.8	29.5	44
Retail	50.0	31.3	12.5	6.3	16	25.4	25.4	25.4	23.8	63
Agricultural	42.6	36.1	13.1	8.2	61	31.9	26.2	16.8	25.1	370
Services	37.5	50.0	4.2	8.3	24	32.3	24.1	13.5	30.1	133
Never worked	55.6	33.3	11.1	0.0	64	28.1	28.4	19.4	24.1	345
		n.s.					n.s.			

NOTE: n.s. signifies p= >0 .05

SOURCE: As for Table 4.6

in the later period, compared with only a little over 30 per cent in Burundi and Uganda.

Only a few variables show a significant relationship with age of death in both the earlier and more recent time periods in Burundi and Uganda, and none in Zimbabwe. This is largely a function of the substantial disparities in sample size between the two periods, but also could indicate a reduction of socio-economic and environmental differentials. It is notable that most variables which are significant for both periods are demographic variables: type of birth, preceding and succeeding birth intervals, and mother's education in Uganda, and mother's age and succeeding birth interval in Burundi. This is again consistent with the marked shift over time in the distribution of age at death. That is, as the overall mortality rate declines, maternal and biological factors become relatively more important than socio-economic factors as causes of death.

As expected, short preceding and succeeding birth intervals and higher birth orders are associated with high percentages of neonatal deaths in each of the three countries. In the case of succeeding birth interval this must be partially attributed to the replacement effect, as discussed in Section 4.3.1. There is also a tendency for higher percentages of neonatal deaths among white-collar workers and more educated mothers and husbands, although these relationships are not significant. Further analysis based on larger data sets would be required to identify significant patterns.

Data limitations preclude further comparative analysis of children born in the earlier and later periods, since child-care variables are available only for children born in the five years preceding the surveys. Also, data for the earlier period are more likely to be affected by maternal memory lapse, and there is a possibility that socio-economic and environmental circumstances could have changed between date of birth, date of death and date of interview. The rest of this analysis of mortality patterns, therefore, focuses on living and dead children born in the five years preceding the surveys. Since growth attainment data also are available for this group, the results can be compared with the analysis of the correlates of growth attainment in Chapter Six.

4.3.3 Survival probabilities

Censoring of cases who have already died is a major constraint in any analysis of the risk of dying of various groups. Even when deaths are grouped by age, as in Tables 4.13, 4.14 and 4.15, simple percentages do not give a true picture of the relative risk at different ages. Children who are already dead are no longer exposed to the risk of dying, so it is inaccurate to include them in the denominator for subsequent age groups.

In order to control for censoring, a survival analysis approach is used here to compare the survival probabilities of children born in the five years preceding the survey. Because of the large number of significant variables in Tables 4.4 to 4.12, only those with a significance level of p=<0.001 were selected, plus preceding birth interval for Zimbabwe.

The number of children alive and dead at the beginning of each one-month period was used to calculate a life table for each category of the selected variables. The l_x values from these life tables indicate the numbers surviving at each age, per 100,000 births, and allow meaningful comparison of the survival probabilities of various groups. They are plotted in Figures 4.1 to 4.21.

In order to enhance readability and to maximise the separation of lines, Figures 4.1 to 4.21 are displayed using a large scale, and the vertical axes have been truncated. In most cases the minimum value is 70,000, but this varies where l_x drops below 70,000, or where l_x values are very close. Steps in the plotted curves occur because of uneven distribution and age heaping of deaths.

As recommended by Kwok et al. (1988: 8), the Mantel-Haenszel test was used to estimate the significance of each plot. This test takes into account the signs of the differences among the estimates of l_x, and tests whether the estimates of l_x are consistently higher or lower when survival functions are compared. When several different survival functions of a single variable are compared, as in Figures 4.1 to 4.21, the l_x values of each function are compared with the average values of the other functions. Under the null hypothesis of no effect for the gth subgroup, the statistic

$$Xg^2 = \frac{Tg^2}{Vg}$$

has an approximate chi-square distribution with one degree of freedom, where Tg^2 is the squared difference between the observed and expected number of terminal events, and Vg is the variance. Under the same hypothesis, a second statistic

$$Zg = \frac{Tg}{Vg}$$

approximates a unit normal distribution and becomes a test for consistent differences. Zg gives the direction of deviation. However, as Kwok et al. (1988: 9) pointed out, because cross-over effects between younger and older age groups can mask consistent differences, it is necessary to consider both the plotted curves and the Mantel-Haenszel statistics.

Table 4.16 presents Xg^2 and Zg for each of the values in the plots in Figures 4.1 to 4.21, and should be referred to in conjunction with the plots. To assist interpretation, especially where there are cross-over effects, columns three and four of the table indicate the relative survival probabilities at ages 0 and 60 months (that is, the relative positions of the curves).

It can be seen that the only variable which does not show a significant difference at the 95 per cent confidence level or higher is dead sibling for Uganda. Given the generally high levels of infant mortality in that country, this finding is not unexpected, and will be explored further in the analysis of household patterns in Chapter Seven. In all other cases there is both a significant and a consistent difference between curves, indicating that these variables have a significant effect on survival probabilities.

Only a few variables have categories which cross: preceding birth interval and province in Burundi; preceding and succeeding birth interval and births in the preceding five years in Uganda, and preceding birth interval in Zimbabwe. In these cases the differences between categories generally remain statistically significant, but the Z^2 value is not meaningful.

Table 4.16: MANTEL-HAENSZEL STATISTICS FOR SURVIVAL PROBABILITIES OF PLOTTED SUBGROUPS: BURUNDI, UGANDA AND ZIMBABWE

	Xg2	Z2	Relative survival probability At age 0	At age 60 mths	n
ALL COUNTRIES (Fig. 4.1)					
Burundi	0.19 **	-0.03	Mid	Mid	3956
Uganda	95.33 **	2.27	Lowest	Lowest	5119
Zimbabwe	104.11 **	2.02	Highest	Highest	3380
BURUNDI					
Births in past 5 yrs (Fig. 4.2)					
1	19.79 **	-0.51	Highest	Highest	1068
2	1.41	2.27	Mid	Mid	2265
3+	51.78 **	4.58	Lowest	Lowest	622
Preceding birth interval (Fig. 4.3)					
First born	8.84 **	0.41	Lowest	Lower mid	640
< 24 months	11.10 **	1.69	Lower mid	Lowest	715
24-35 months	1.36 **	0.77	Upper mid	Upper mid	1591
36 months +	17.69 **	0.36	Highest	Highest	995
Succeeding birth interval (Fig. 4.4)					
< 24 months	141.96 **	1.67	Lowest	Lowest	473
24-35 months	49.68 **	1.39	Mid	Mid	838
36 months +	21.11 **	3.76	Highest	Highest	273
Dead sibling (Fig. 4.5)					
No	10.35 **	-0.33	Higher	Higher	2324
Yes		2.05	Lower	Lower	1633
Multiple birth (Fig. 4.6)					
No	50.32 **		Higher	Higher	3894
Yes			Lower	Lower	33
Province (Fig. 4.7)					
Central Plateau	3.22	-0.06	Upper mid	Lower mid	2161
Mumirwa	60.22 **	0.78	Highest	Highest	451
Mugamba	11.60 **	1.40	Mid	Upper mid	379
Depressions	22.45 **	0.31	Lowest	Mid	640
Imbo	530.63 **	1.20	Lower mid	Lowest	313
Number in household (Fig. 4.8)					
1-6	50.39 **	0.73	Lowest	Lowest	2073
7-10	33.34 **	0.97	Highest	Highest	1384
11 +	5.52 *	3.28	Mid	Mid	494
UGANDA					
Births in past 5 yrs (Fig. 4.9)					
1	6.76 *	-0.23	Highest	Mid	1264
2	28.26 **	1.69	Mid	Highest	2598
3+	79.80 **	2.92	Lowest	Lowest	1255
Preceding birth interval (Fig. 4.10)					
First born	10.18 **	0.32	Lower mid	Lowest	951
< 24 months	7.86 *	1.59	Lowest	Lower mid	1192
24-35 months	16.25 **	1.02	Highest	Upper mid	1864
36 months +	1.52	0.32	Upper mid	Highest	1111

** p = < .001   * p = < .05

(continued)

Table 4.16 (continued)

Succeeding birth interval (Fig. 4.11)					
< 24 months	105.07 **	1.07	Lowest	Lowest	823
24-35 months	66.59 **	1.33	Mid	Highest	1067
36 months +	6.20 *	4.90	Highest	Mid	256
Birth order (Fig. 4.12)					
1-5	10.96 **	2.08	Mid	Lowest	3580
6-10	12.53 **	1.10	Highest	Highest	1406
11+	0.15	10.74	Lowest	Lowest	139
Dead sibling (Fig. 4.13)					
No	0.72	-0.07	Higher	Lower	2769
Yes		1.92	Lower	Higher	2274
Multiple birth (Fig. 4.14)					
No	68.84 **	-1.81	Higher	Higher	4939
Yes		2.87	Lower	Lower	189
Number in household (Fig. 4.15)					
1-6	34.75 **	0.46	Lowest	Lowest	2704
7-10	16.67 **	1.27	Mid	Mid	1830
11 +	9.31 *	3.54	Highest	Highest	594
ZIMBABWE					
Births in past 5 yrs (Fig. 4.16)					
1	19.66 **	-0.66	Highest	Highest	1311
2	3.94 *	171.00	Mid	Mid	1611
3+	98.00 **	4.92	Lowest	Lowest	408
Preceding birth interval (Fig. 4.17)					
First born	0.69	-0.15	Highest	Upper mid	687
< 24 months	10.55 **	1.85	Lowest	Lowest	497
24-35 months	1.38	0.67	Upper mid	Lower mid	1143
36 months +	0.33	0.41	Lower mid	Highest	1053
Succeeding birth interval (Fig. 4.18)					
< 24 months	97.53 **	2.25	Low	Low	305
24-35 months	29.37 **	1.20	Mid	Mid	597
36 months +	17.31 **	3.70	Highest	Highest	200
Dead sibling (Fig. 4.19)					
No	45.96 **	-1.20	Higher	Higher	2493
Yes		2.49	Lower	Lower	682
Multiple birth (Fig. 4.20)					
No	17.13 **	-1.58	Higher	Higher	3250
Yes		2.64	Lower	Lower	131
Mother's literacy (Fig. 4.21)					
Reads	10.95 **	-0.56	Higher	Higher	2579
Cannot Read		1.89	Lower	Lower	801

** p = < 0.C** p = < 0.001 * p = <0 .05

SOURCE: As for Tables 4.4, 4.5 and 4.6.

Figure 4.1 compares the overall survival probabilities for the three countries. It can be seen that, at all ages, survival probabilities are highest in Zimbabwe, and higher in Burundi than in Uganda. After the first few months the curves for Burundi and Uganda are almost parallel, but the curve for Zimbabwe is flatter, indicating a higher probability of survival.

Figures 4.2 to 4.8 compare survival probabilities for selected variables for Burundi. In almost all cases the patterns are much as expected. Figure 4.2 shows that survival of children whose mothers had only one birth in the preceding five years is higher than that of children whose mothers had two births, while those whose mothers had three births is considerably lower. Similarly, preceding and succeeding birth intervals of less than two years are associated with reduced survival probabilities, as shown in Figures 4.3 and 4.4. It is notable that the survival of first births is poor, close to that of births with preceding intervals of less than 24 months. Another striking feature is the much lower survival probabilities of children with succeeding birth intervals of less than 24 months. Again it must be emphasised that this is likely to be composed of both a replacement effect, when conception of the succeeding child occurred after the index child was dead, and an effect of increased competition, when conception occurred before the index child died.

Figure 4.5 indicates surprisingly little variation in the survival probabilities of Burundais children with and without a dead sibling. It appears that the advantage of having fewer competing siblings up to age five offsets any disadvantages which led to the death of the sibling. This phenomenon was noted also by Majumder (1989) in his study of Bangladesh. Predictably, multiple births are greatly disadvantaged compared with singleton births (Figure 4.6). However, the highest risks for multiple births are in the first year of life, and thereafter do not appear to increase relative to those of single births. This reflects the predominance of biological factors in the higher mortality of multiple births.

The survival probabilities by province shown in Figure 4.7 indicate the very disadvantaged position of Imbo province compared with others. As discussed above, this is probably due to poor conditions in urban townships, and to the greater risk of malaria and other water-borne diseases in Imbo, which borders Lake Tanganyika. This apparently offsets the survival advantages of the few privileged cases living in

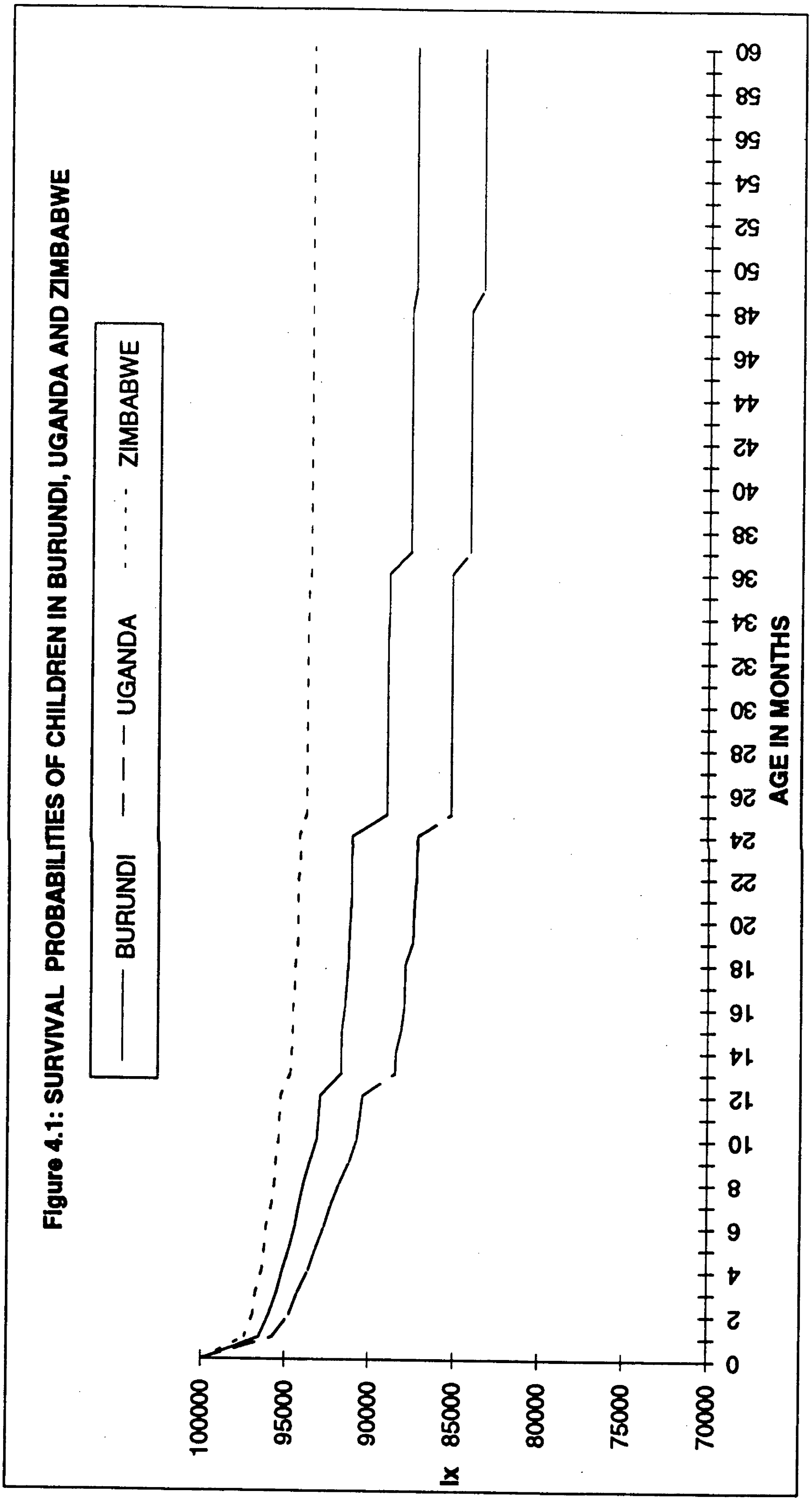


Figure 4.1: SURVIVAL PROBABILITIES OF CHILDREN IN BURUNDI, UGANDA AND ZIMBABWE

SOURCE: As for Table 4.4.

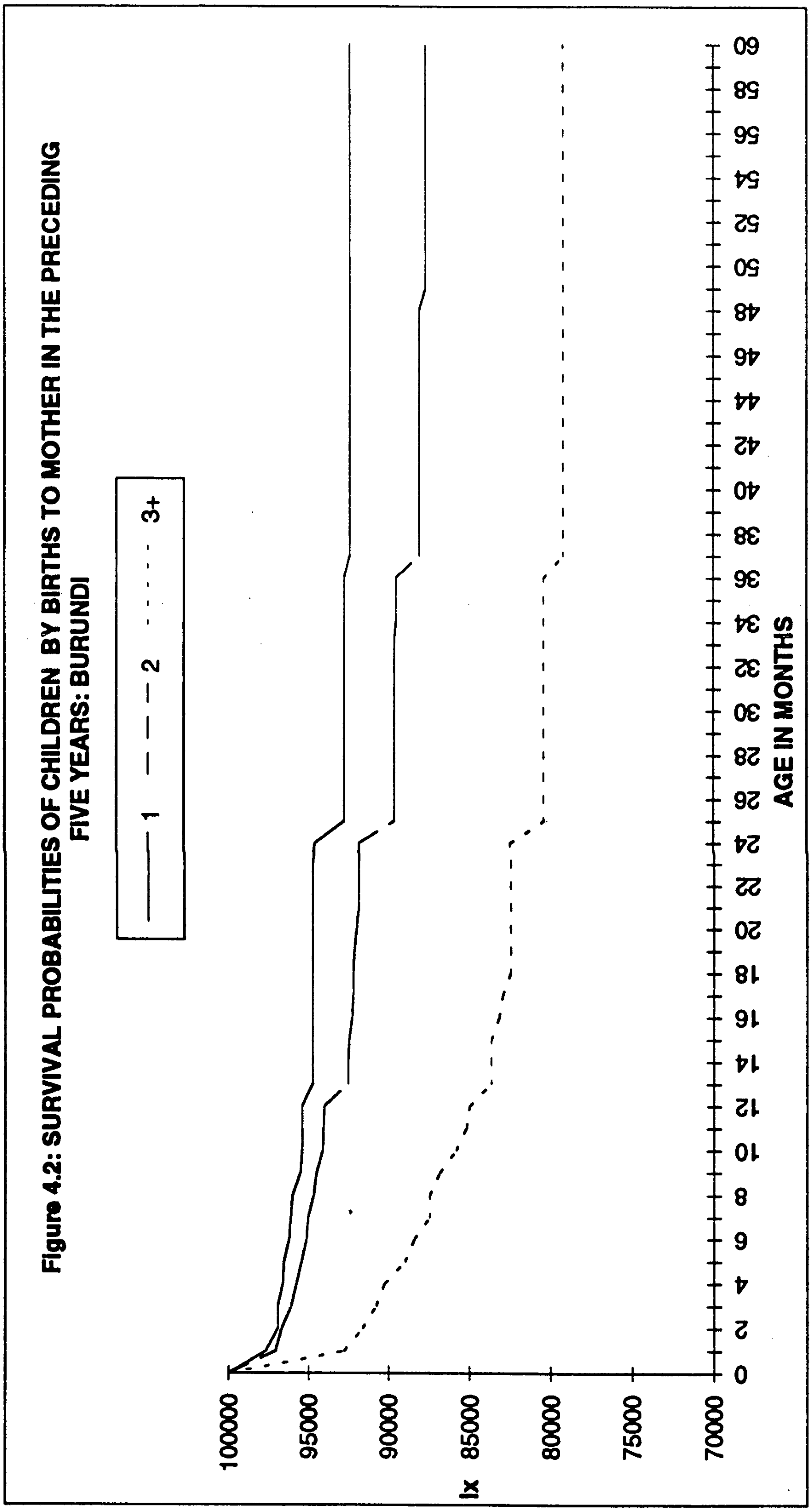


Figure 4.2: SURVIVAL PROBABILITIES OF CHILDREN BY BIRTHS TO MOTHER IN THE PRECEDING FIVE YEARS: BURUNDI

SOURCE: As for Table 4.4.

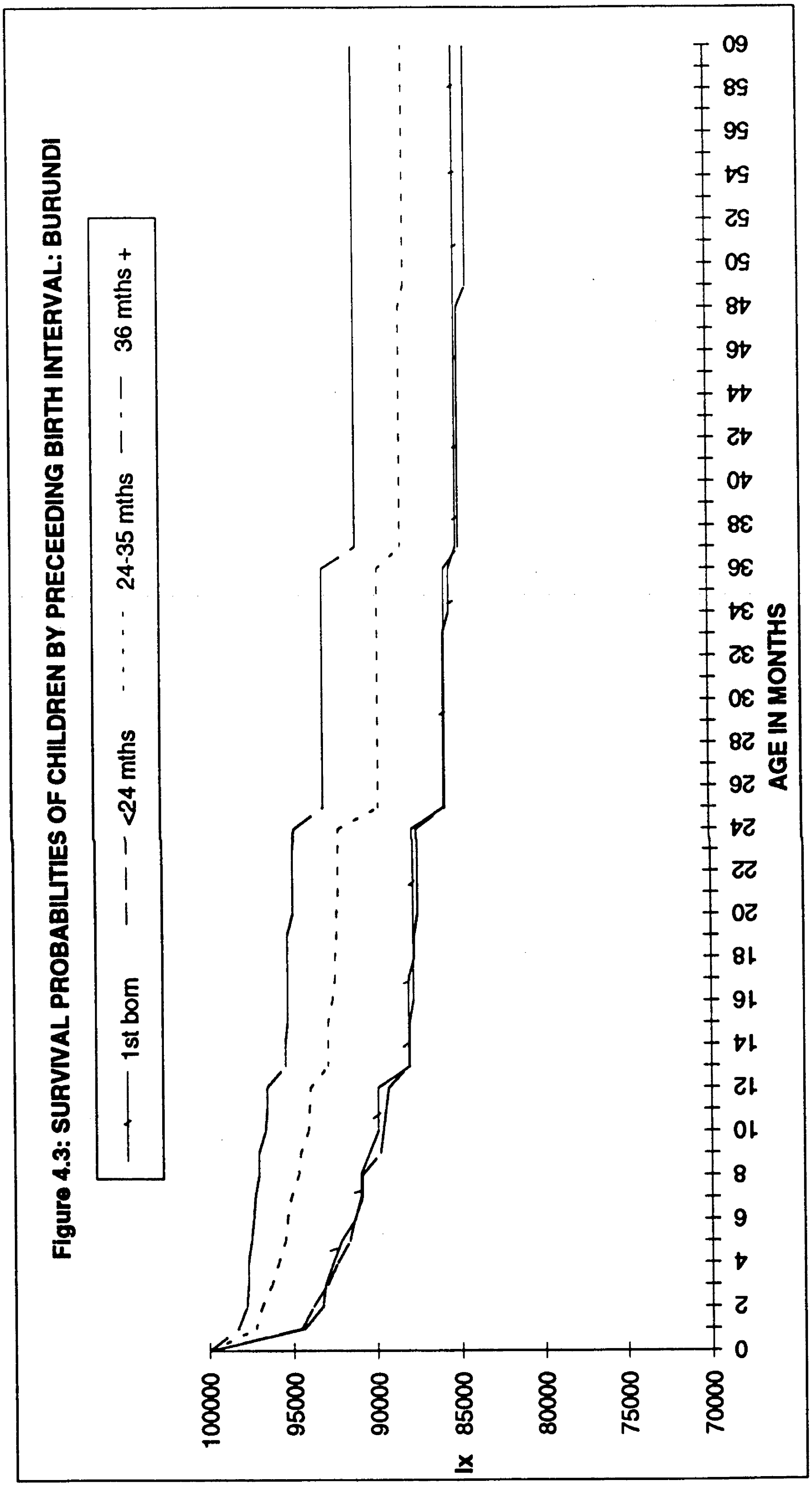


Figure 4.3: SURVIVAL PROBABILITIES OF CHILDREN BY PRECEEDING BIRTH INTERVAL: BURUNDI

SOURCE: As for Table 4.4.

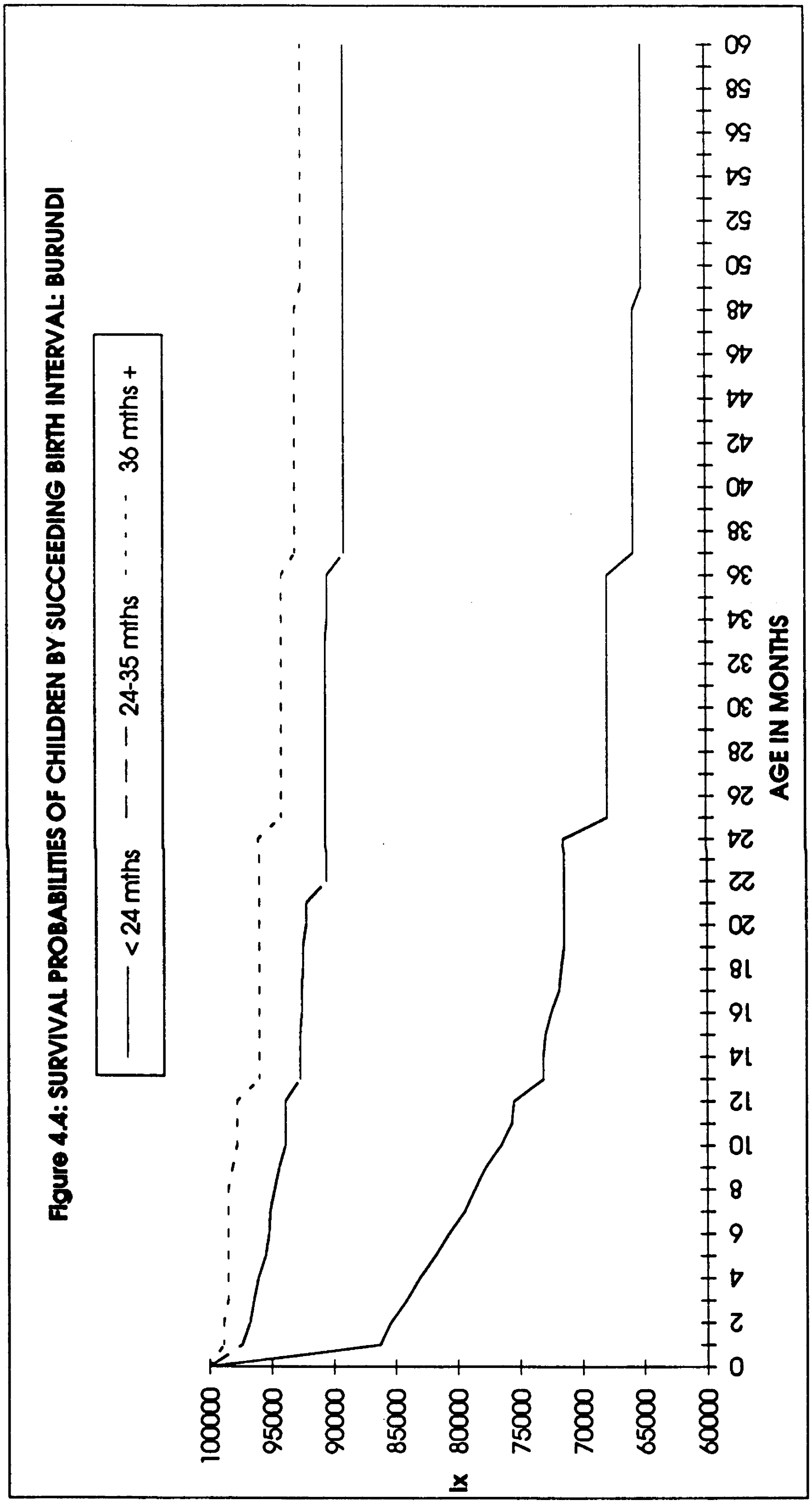


Figure 4.4: SURVIVAL PROBABILITIES OF CHILDREN BY SUCCEEDING BIRTH INTERVAL: BURUNDI

SOURCE: As for Table 4.4.

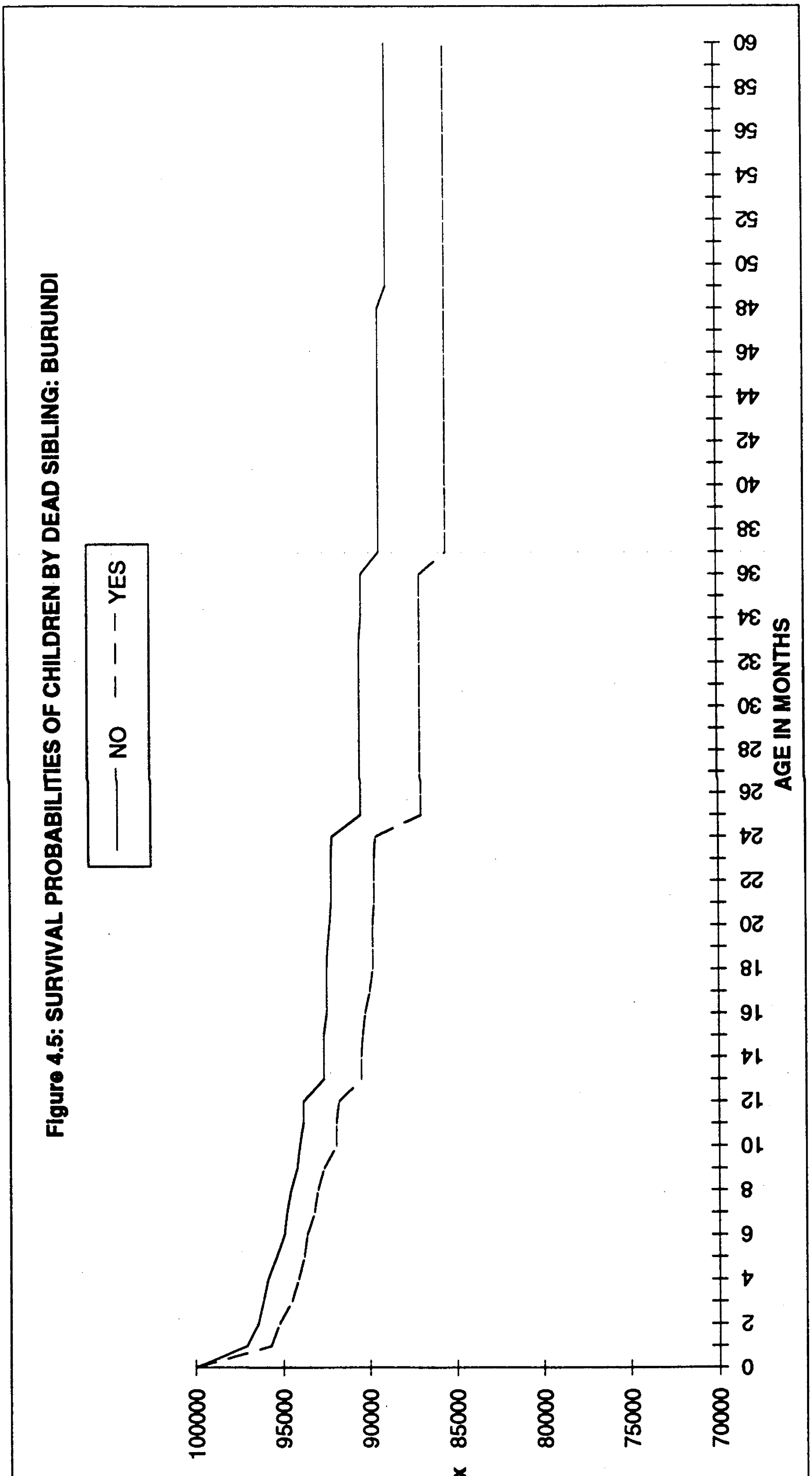
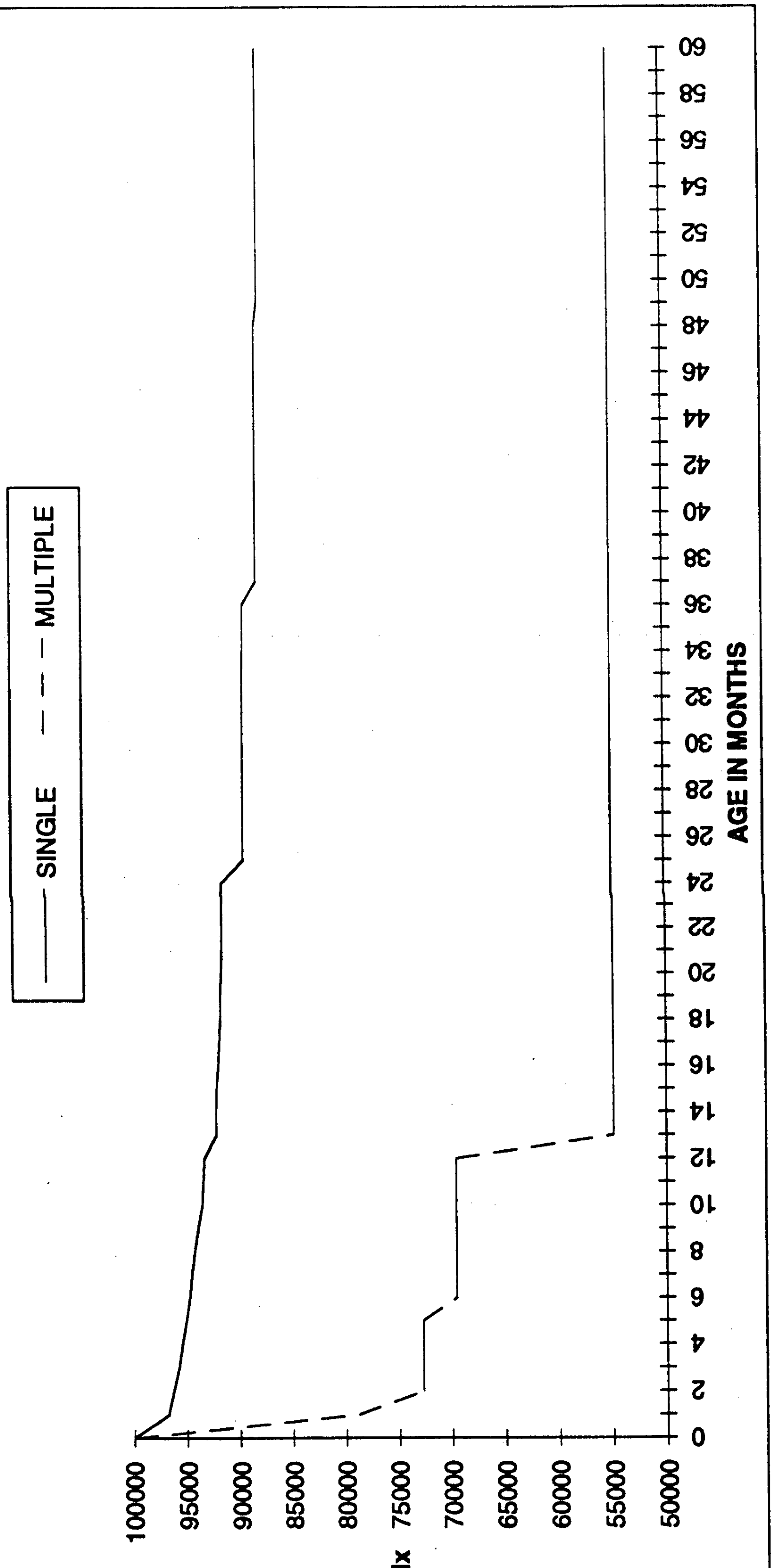


Figure 4.5: SURVIVAL PROBABILITIES OF CHILDREN BY DEAD SIBLING: BURUNDI

SOURCE: As for Table 4.4.

Figure 4.6: SURVIVAL PROBABILITIES OF SINGLE AND MULTIPLE BIRTHS: BURUNDI



SOURCE: As for Table 4.4.

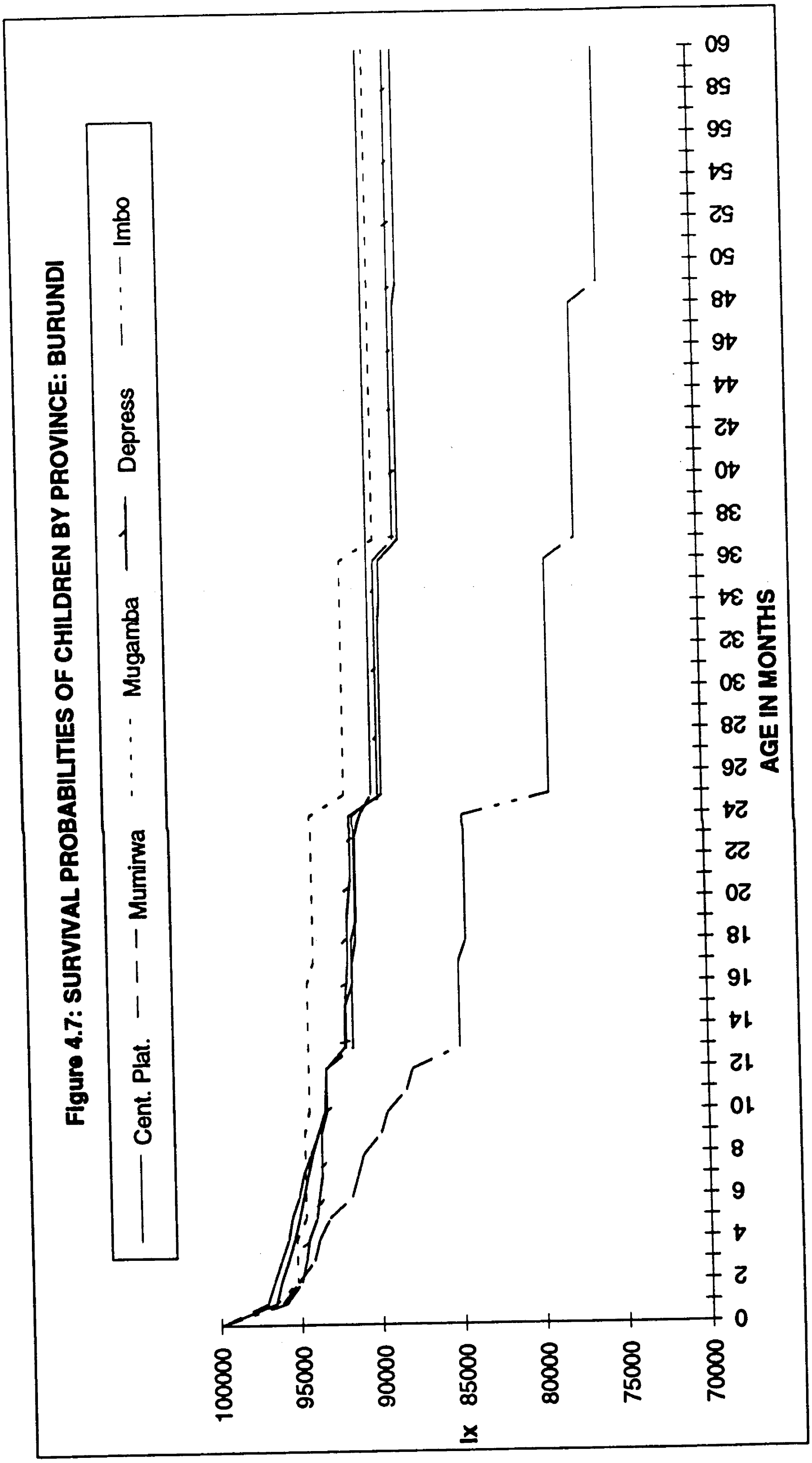


Figure 4.7: SURVIVAL PROBABILITIES OF CHILDREN BY PROVINCE: BURUNDI

SOURCE: As for Table 4.4.

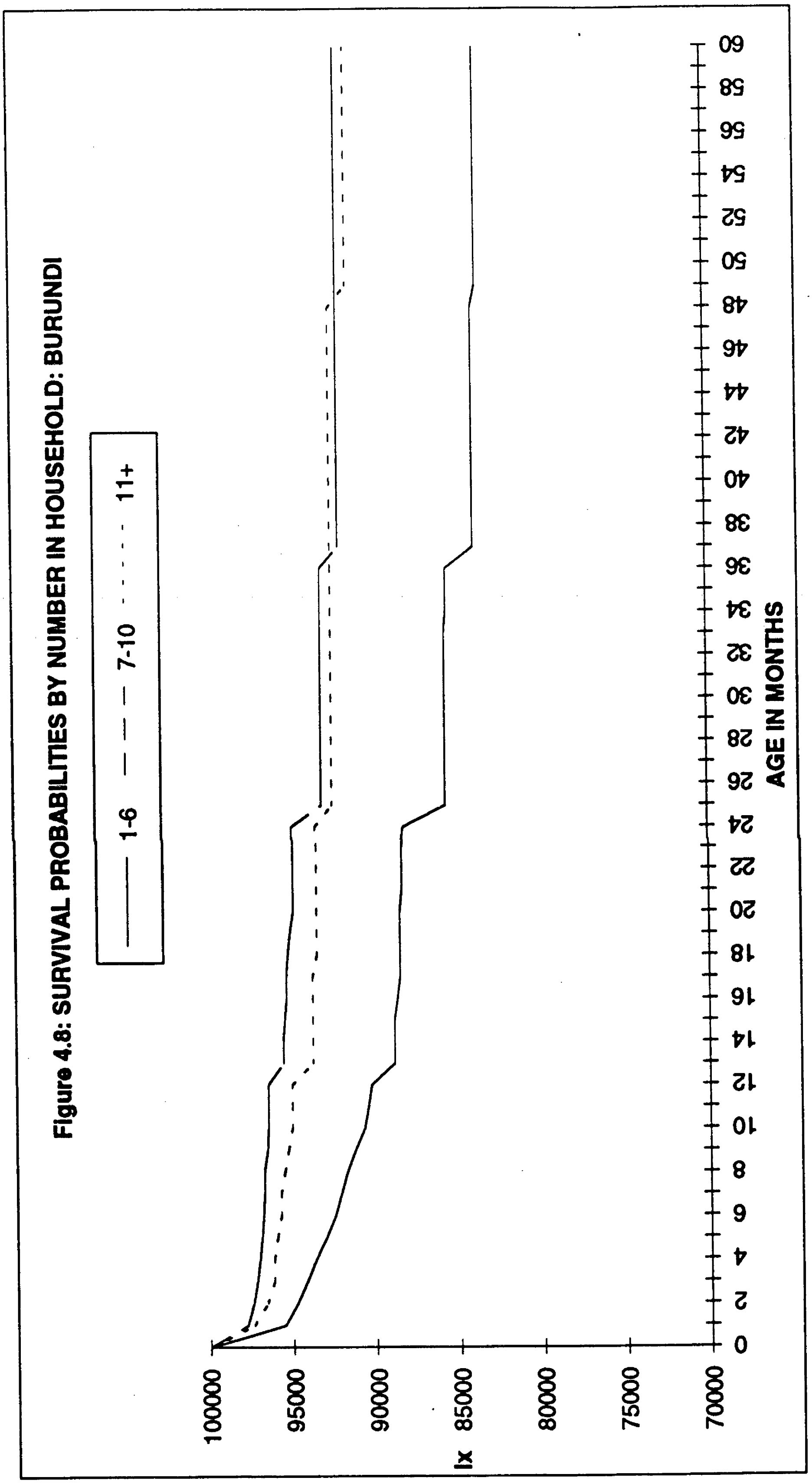


Figure 4.8: SURVIVAL PROBABILITIES BY NUMBER IN HOUSEHOLD: BURUNDI

SOURCE: As for Table 4.4.

Bujumbura, who benefit from electricity, household water and sanitation and educated, professional parents.

Household size also appears to have a strong relationship with child survival in Burundi, as shown in Figure 4.8. Survival probabilities of children in households of seven or more are considerably better off than children in small households. This suggests that smaller households are more likely to be economically disadvantaged in Burundi, while larger households may have more carers. It also must be recognised that small household size itself can be a consequence of higher mortality.

Survival probabilities for those variables found to be highly significant in Uganda are shown in Figures 4.9 to 4.15. As in Burundi, children whose mothers had three or more births in the five years preceding the survey are considerably worse off than those with fewer young siblings (Figure 4.9). The patterns for preceding and succeeding birth intervals in Figures 4.10 and 4.11 are also similar to those for Burundi. However, Ugandan first-born children aged two years or more actually have a lower probability of surviving than those with a preceding birth interval of less than two years, while there is little difference between succeeding birth intervals of 24-35 months and 36 months or more. The Ugandan pattern by birth order in Figure 4.12 is less clear. The many cross-overs between groups suggest no consistent difference, even though birth orders 6-10 are advantaged at both the beginning and end of the age range.

As in Burundi, having a dead sibling appears to make little difference to survival probabilities in Uganda (Figure 4.13). It seems that, in both countries, the advantage of having less competition after the death of a sibling offsets the disadvantages that led to that death. The pattern for single and multiple births also is similar to that for Burundi, with the risks for multiple births greatest in the first year of life and then paralleling those of singleton births (Figure 4.14). Finally, as in Burundi, children in larger households have higher survival probabilities than those in households of from 1-6 members (Figure 4.15). In the case of Uganda, this almost certainly reflects social disruption as a result of political conflict, as well as the disadvantaged economic position of newly established nuclear families, or broken families, compared with that of extended families.

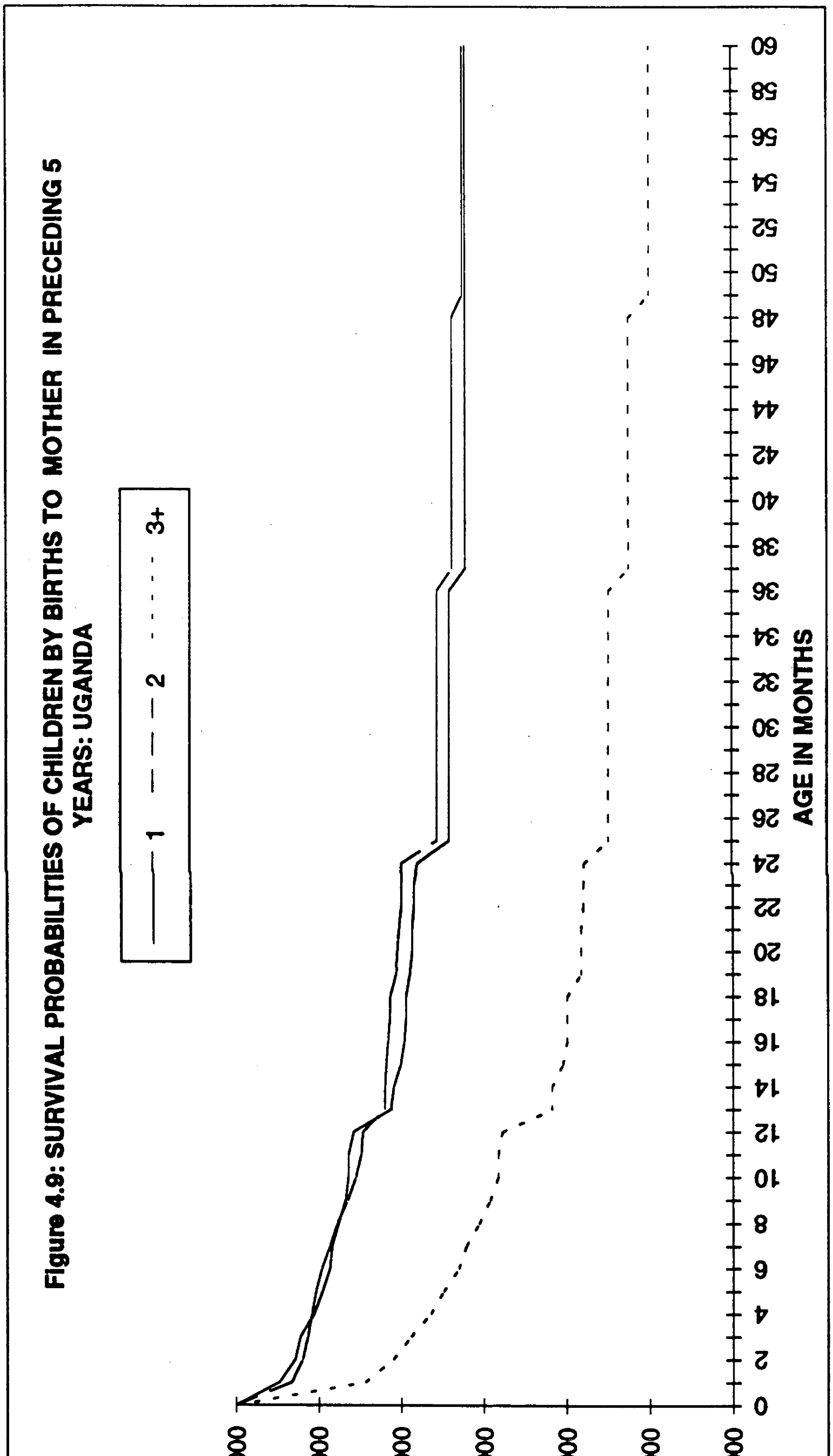


Figure 4.9: SURVIVAL PROBABILITIES OF CHILDREN BY BIRTHS TO MOTHER IN PRECEDING 5 YEARS: UGANDA

SOURCE: As for Table 4.5.

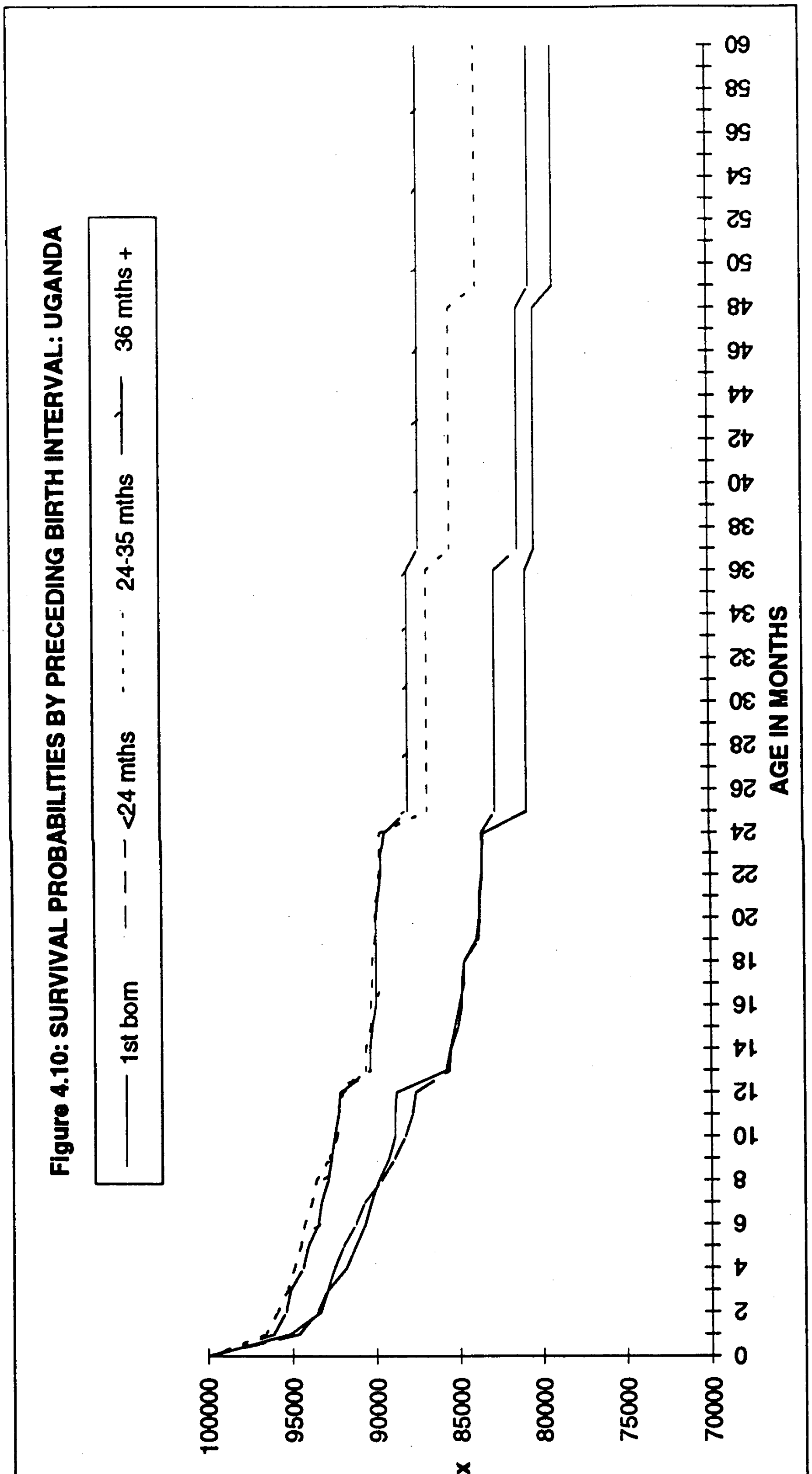
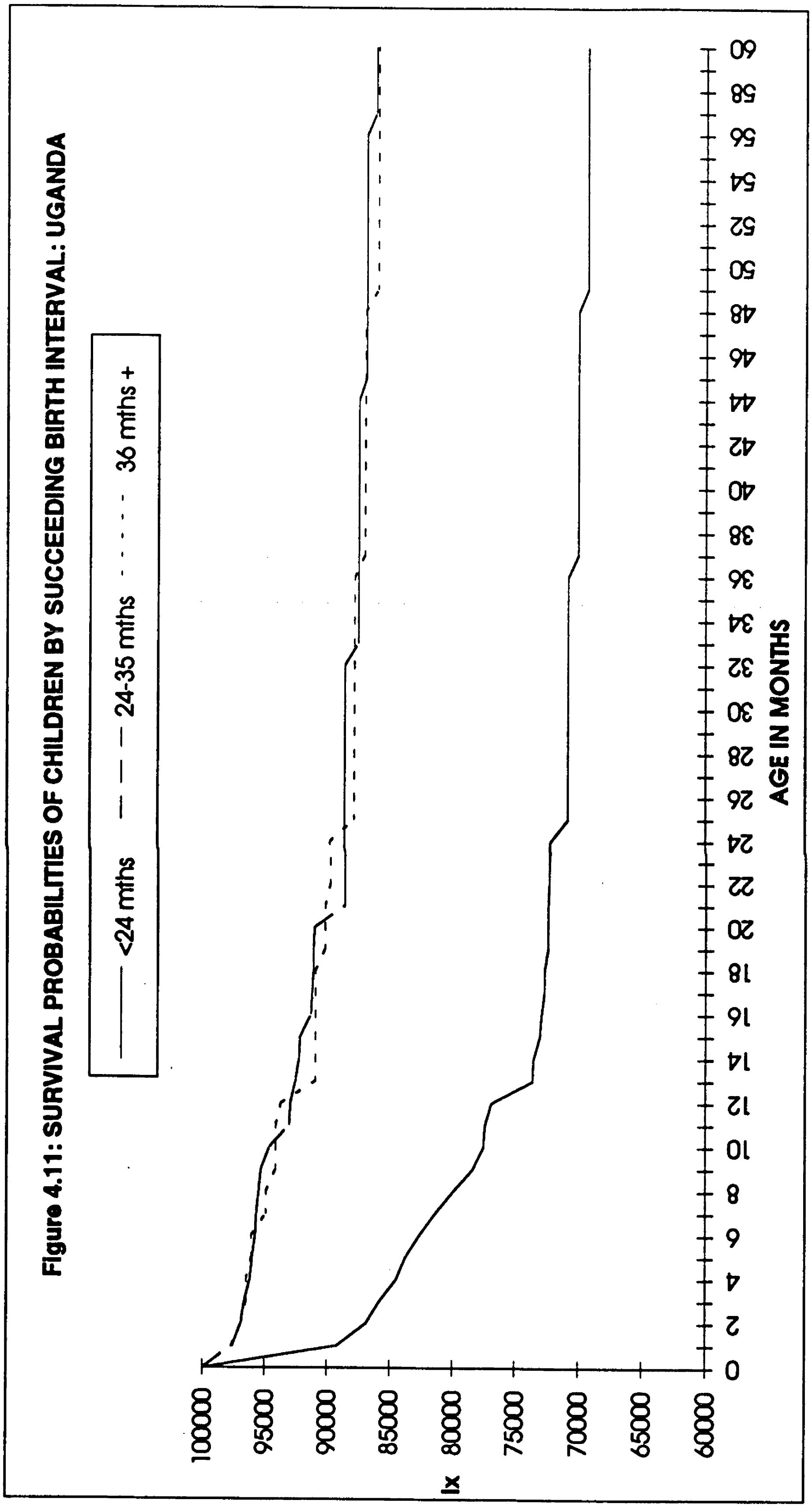


Figure 4.10: SURVIVAL PROBABILITIES BY PRECEDING BIRTH INTERVAL: UGANDA

SOURCE: As for Table 4.5.

Figure 4.11: SURVIVAL PROBABILITIES OF CHILDREN BY SUCCEEDING BIRTH INTERVAL: UGANDA



SOURCE: As for Table 4.5.

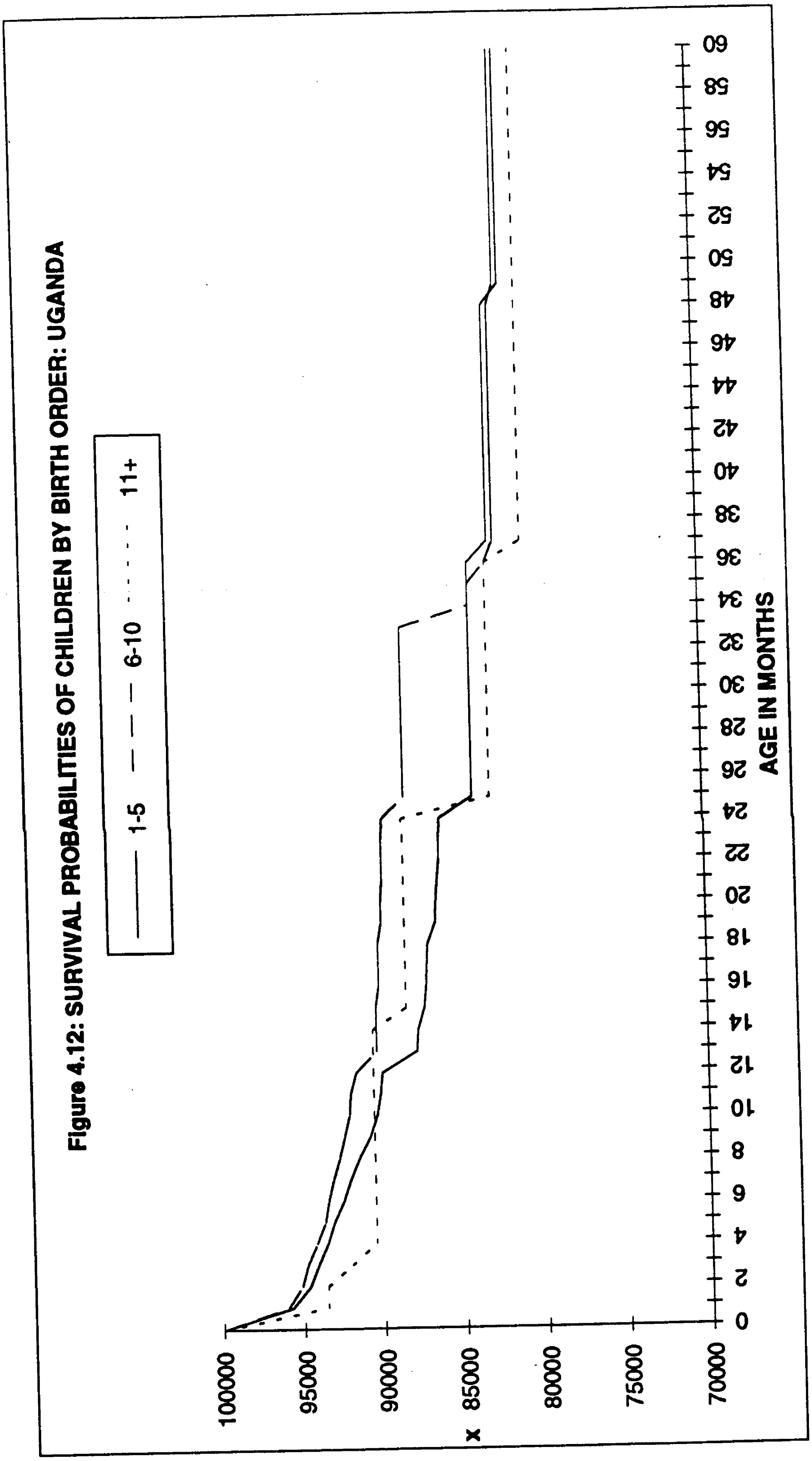


Figure 4.12: SURVIVAL PROBABILITIES OF CHILDREN BY BIRTH ORDER: UGANDA

SOURCE: As for Table 4.5.

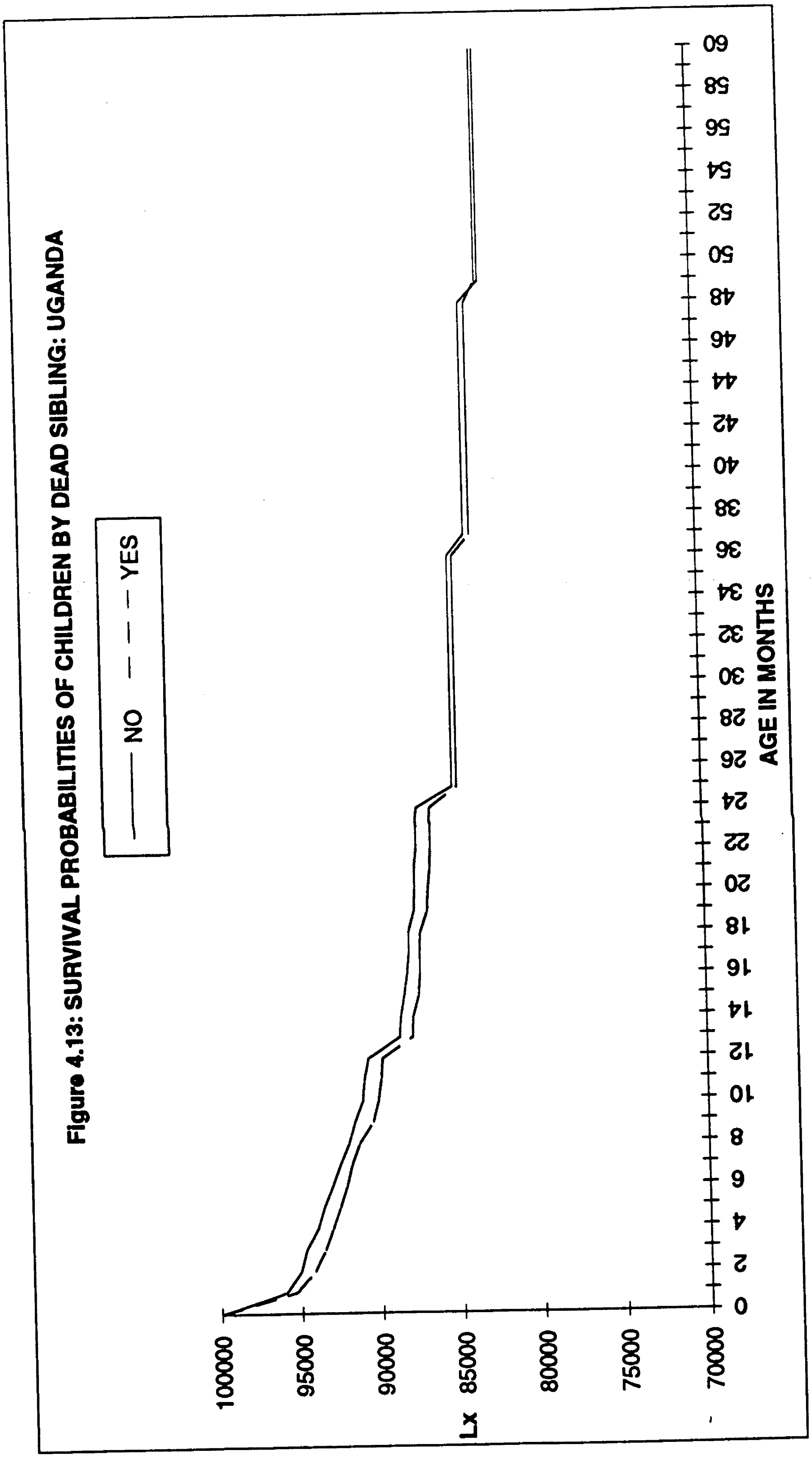
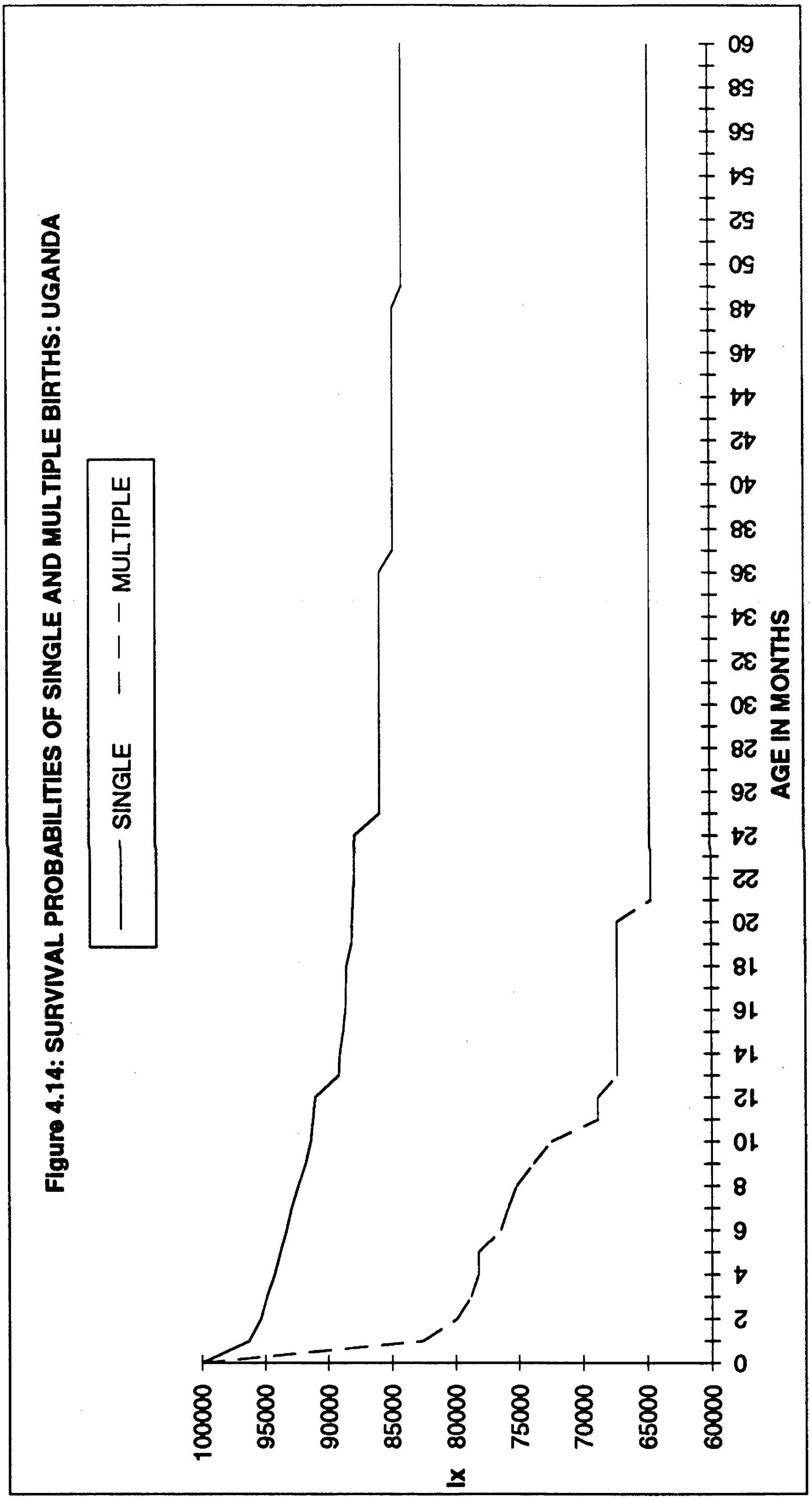


Figure 4.13: SURVIVAL PROBABILITIES OF CHILDREN BY DEAD SIBLING: UGANDA

SOURCE: As for Table 4.5.



SOURCE: As for Table 4.5.

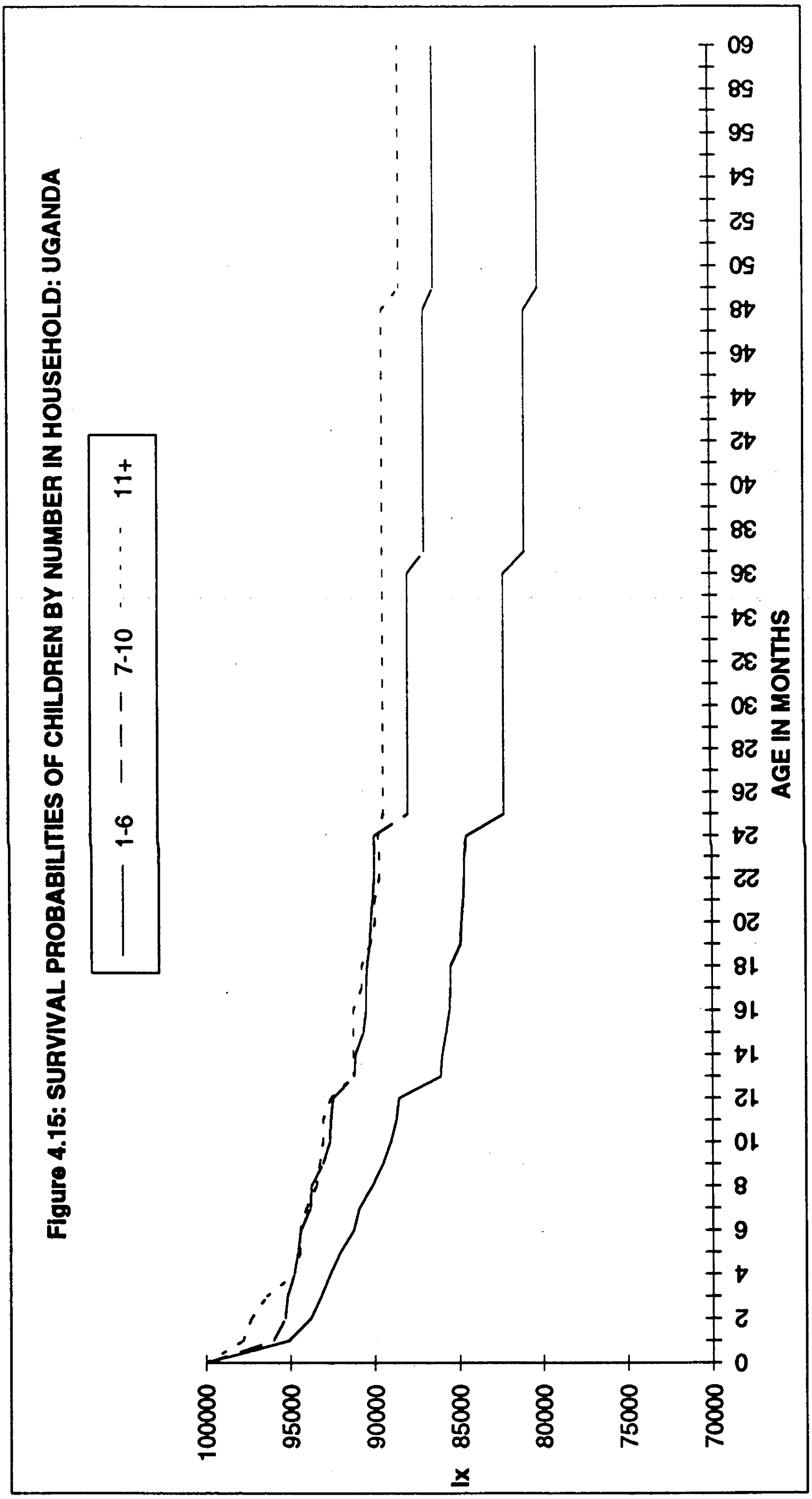


Figure 4.15: SURVIVAL PROBABILITIES OF CHILDREN BY NUMBER IN HOUSEHOLD: UGANDA

SOURCE: As for Table 4.5.

The patterns for Zimbabwe show more variation than those for Burundi and Uganda. As in the two other countries, children whose mothers had three or more births in the preceding five years were considerably disadvantaged compared with others (Figure 4.16). Similarly, preceding and succeeding birth intervals of less than 24 months substantially reduced survival probabilities (Figures 4.17 and 4.18).

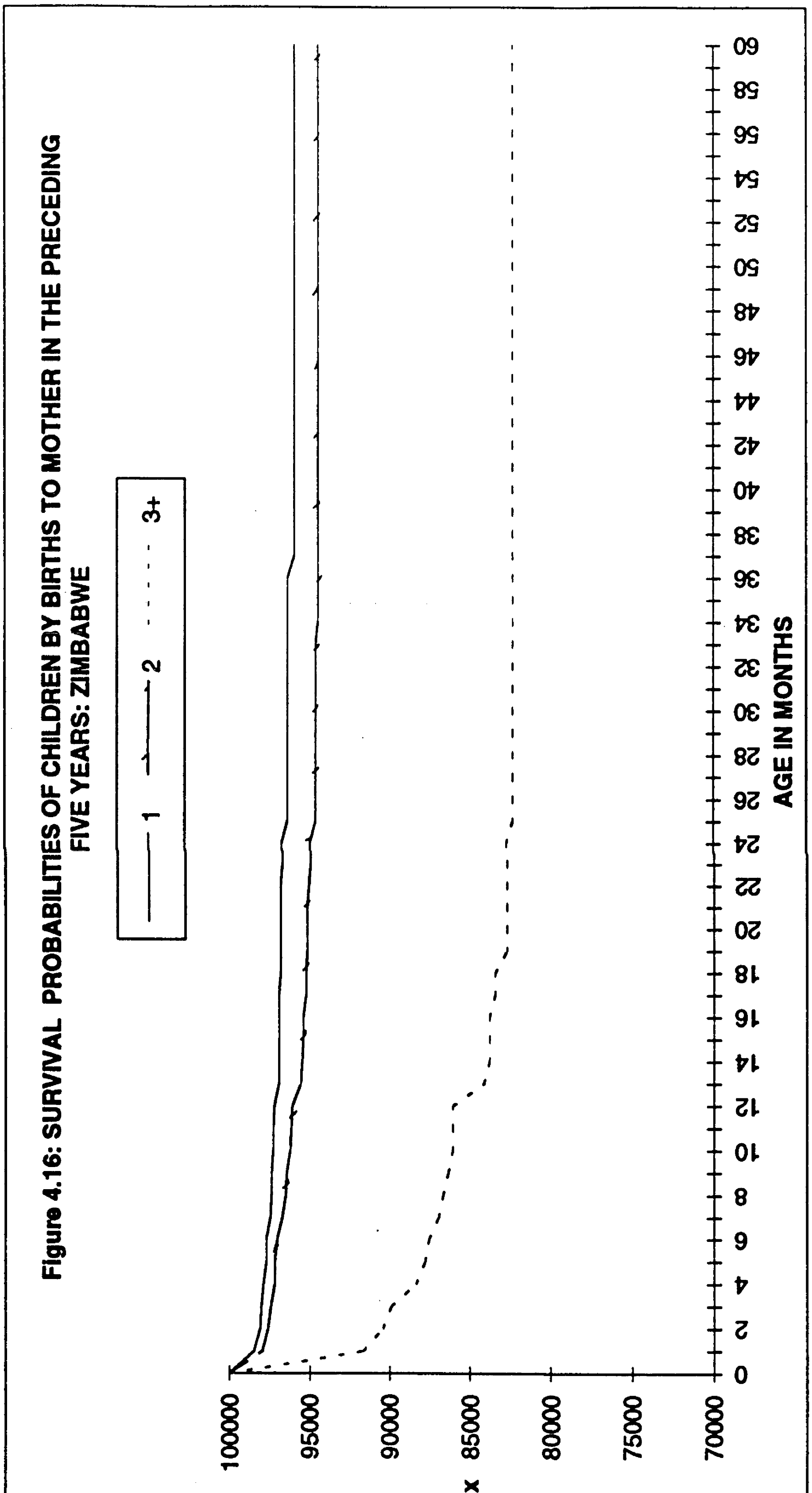
In contrast to Burundi and Uganda, there is a marked difference between children with and without a dead sibling, as shown in Figure 4.19. The overall mortality rate is lower in Zimbabwe, while the general living standard is higher. This suggests that deaths could be more likely to cluster as overall living standards improve. This pattern will be explored further in Chapter Seven.

Figure 4.20 shows that, as in Burundi and Uganda, multiple births have reduced survival probabilities compared with singleton births, but the l_x values for Zimbabwean multiple births are much higher than in Burundi and Uganda. Again, this is a reflection of the superior health services and better living conditions in Zimbabwe.

Figure 4.21 shows a marked, if small, difference in the survival probabilities of children with literate and illiterate mothers, which is both significant and consistently different. As suggested above in the discussion of health care, it seems that the main differences in Zimbabwe are between children of a small group of disadvantaged mothers and the rest, rather than differences according to a range of demographic factors. Chapter Seven will seek to isolate these factors and compare the extent to which deaths cluster in the three countries.

To summarize, Figures 4.1 to 4.21 plot child survival probabilities according to variables with a p value of <0.001 or less in Tables 4.4 to 4.12, plus *preceding birth interval* for Zimbabwe. With the exception of *number in household* in Burundi and Uganda, *region* in Burundi and *mother's literacy* in Zimbabwe, all are demographic variables. The plots demonstrate that all selected variables also are associated with differences in survival probabilities when censoring is controlled, and most of the differences are consistent and statistically significant.

Figure 4.16: SURVIVAL PROBABILITIES OF CHILDREN BY BIRTHS TO MOTHER IN THE PRECEDING FIVE YEARS: ZIMBABWE



SOURCE: As for Table 4.6.

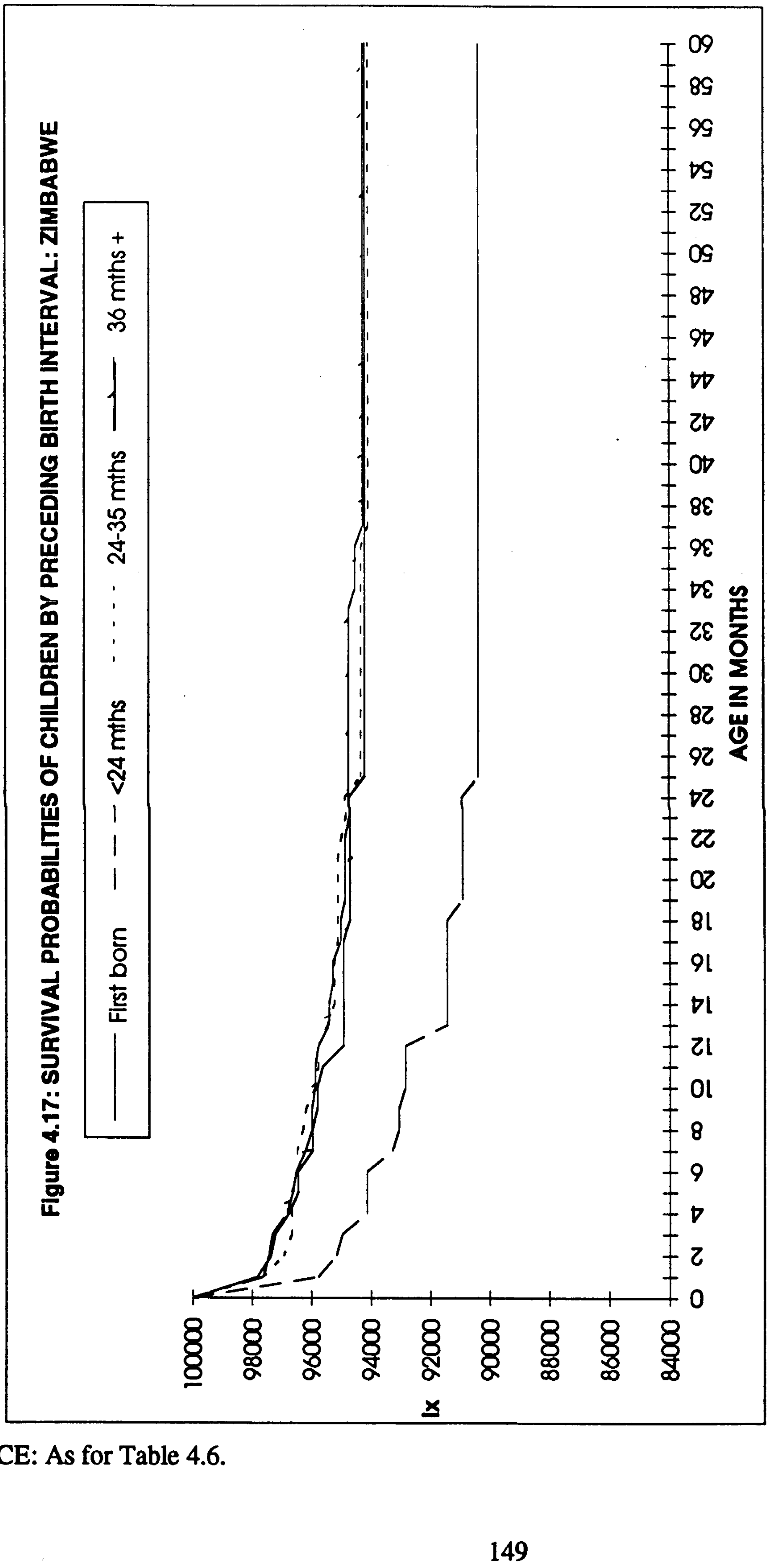


Figure 4.17: SURVIVAL PROBABILITIES OF CHILDREN BY PRECEDING BIRTH INTERVAL: ZIMBABWE

SOURCE: As for Table 4.6.

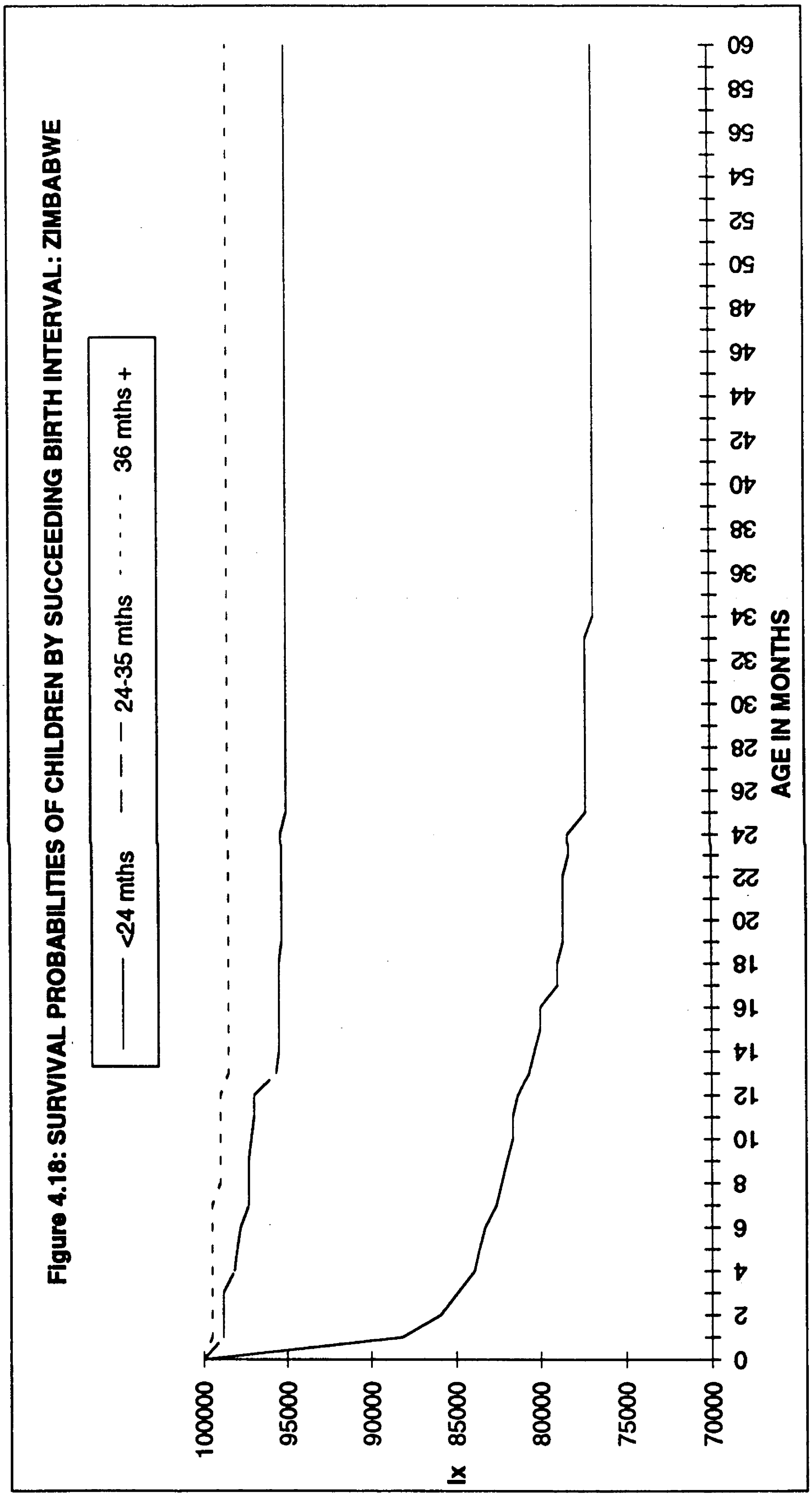
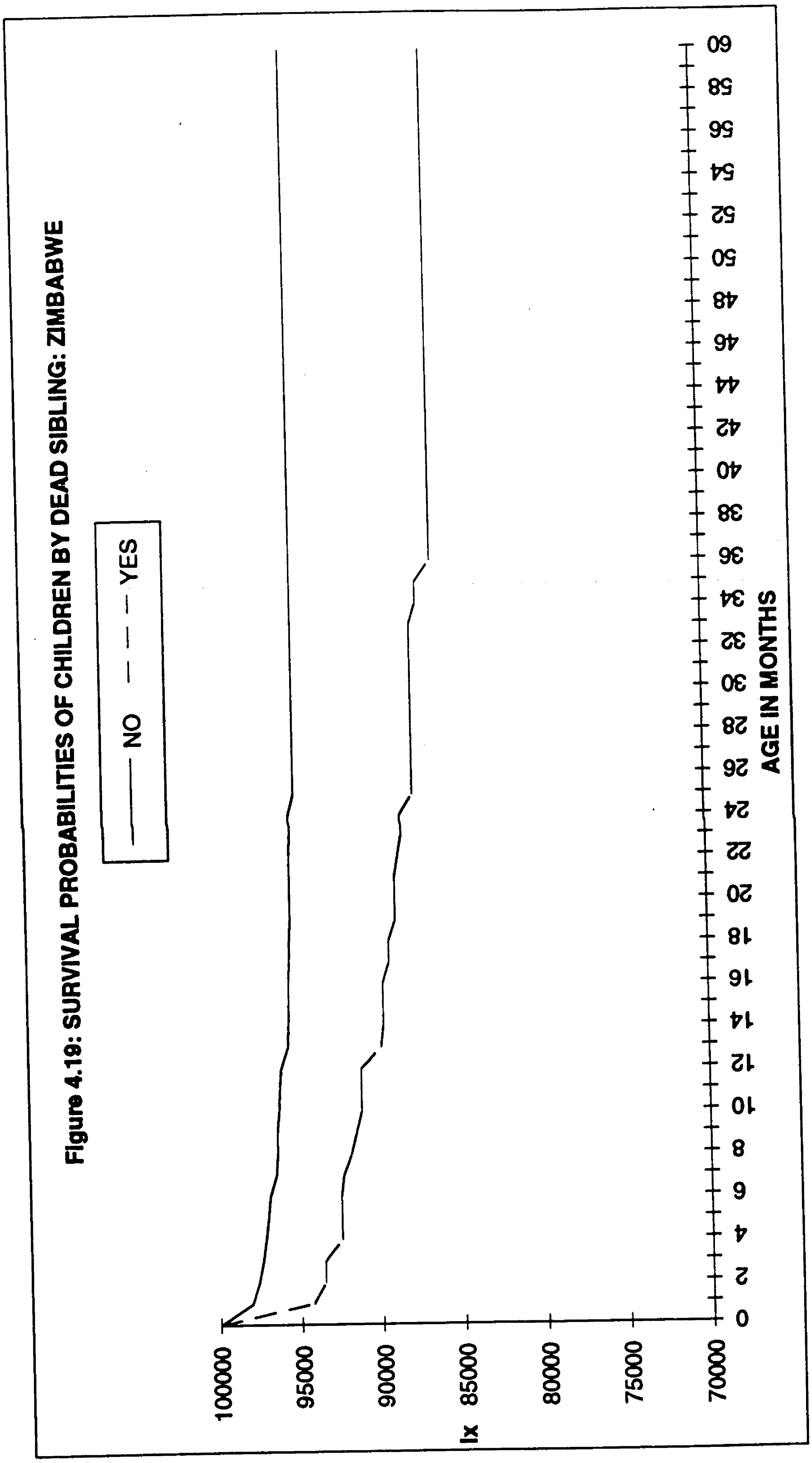


Figure 4.18: SURVIVAL PROBABILITIES OF CHILDREN BY SUCCEEDING BIRTH INTERVAL: ZIMBABWE

SOURCE: As for Table 4.6.

Figure 4.19: SURVIVAL PROBABILITIES OF CHILDREN BY DEAD SIBLING: ZIMBABWE



SOURCE: As for Table 4.6.

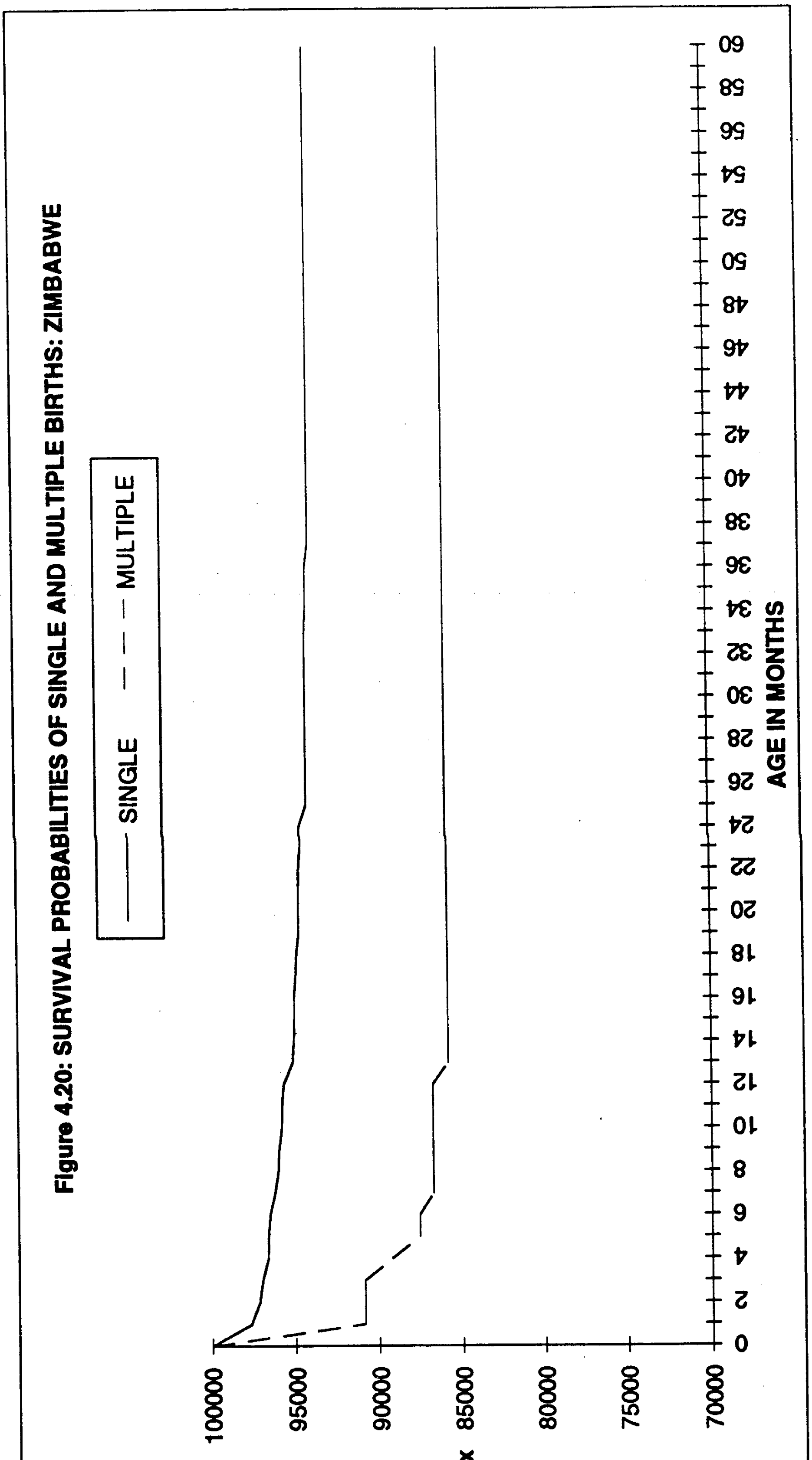


Figure 4.20: SURVIVAL PROBABILITIES OF SINGLE AND MULTIPLE BIRTHS: ZIMBABWE

SOURCE: As for Table 4.6.

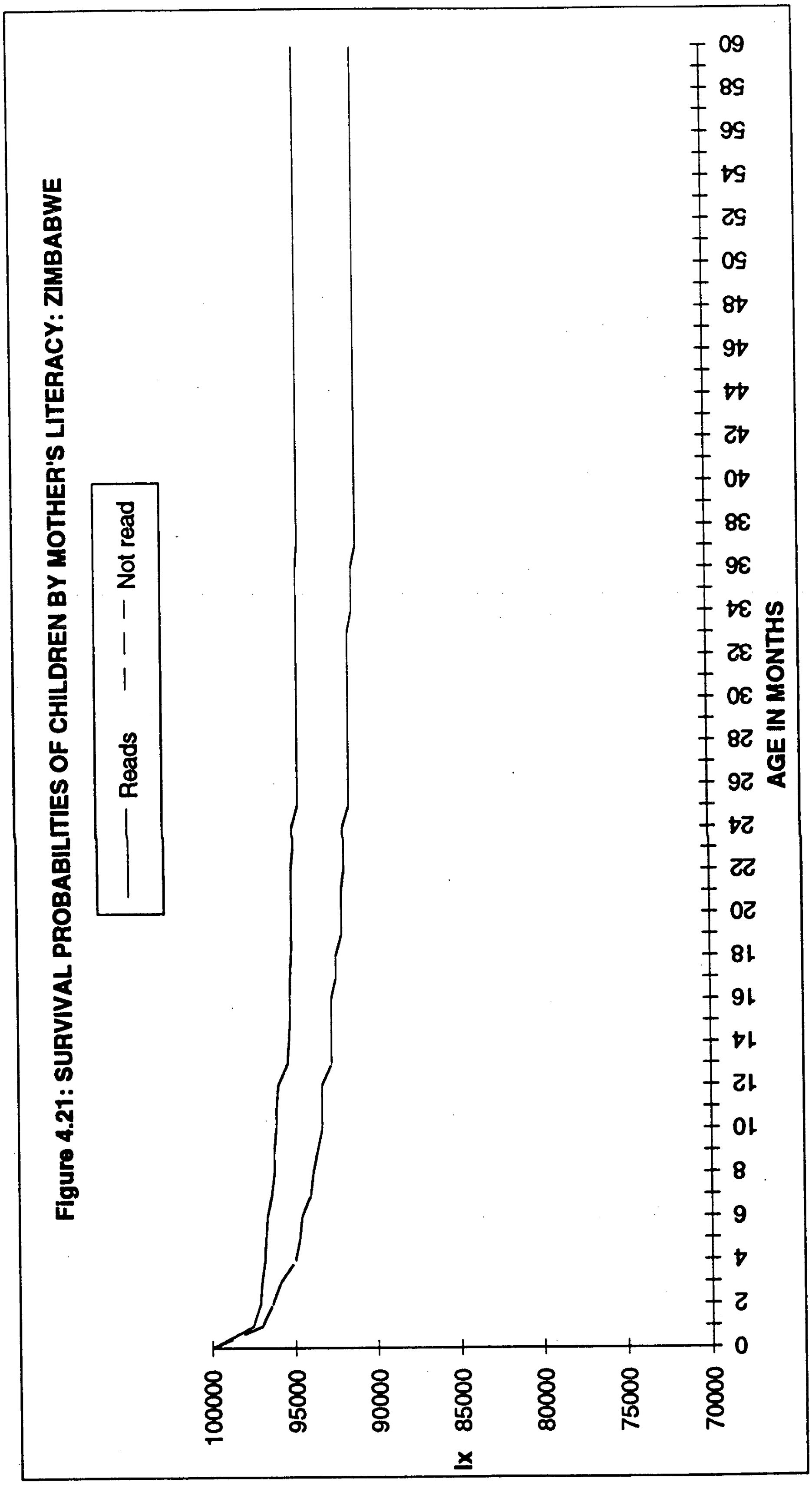


Figure 4.21: SURVIVAL PROBABILITIES OF CHILDREN BY MOTHER'S LITERACY: ZIMBABWE

SOURCE: As for Table 4.6.

4.3.4 Immunization and health care

As discussed above, although the pattern of mortality decline in the three countries indicates that immunization and health care are important factors, DHS surveys include only very limited data on care of children who died before the survey. Their health cards were not requested by interviewers, and childhood immunization data were not recorded. Although mothers were asked why they stopped breastfeeding children who had died, it appears they may have been reluctant to discuss this topic. The reason for weaning is missing for more than 80 per cent of dead children in each country. Of the remainder, sickness or death of the child is given as the reason for 53 per cent in Burundi, 24 per cent in Uganda and 60 per cent in Zimbabwe. In most cases the duration of breastfeeding is equal to the age at death.

Since there are no data on cause of death or place of death, it is difficult to interpret the breastfeeding data. For example, it is not possible to determine whether early weaning occurred first and cessation of breastfeeding contributed to the death, or whether the mother ceased breastfeeding because the child was taken into clinic or hospital care before it died. Lantz, Partin and Palloni (1992: 3-4) discussed the limitations of retrospective surveys of breastfeeding, and concluded that such errors may have led to overestimation of the beneficial effect of breastfeeding on child survival. On the basis of an analysis of 39 WFS data sets, Hobcraft, McDonald and Rutstein (1985: 374) asserted that it is more likely that early infant death causes the termination of breastfeeding than that a decision to terminate breastfeeding leads to an early child death. They consider this is especially true in Africa and Asia, where prolonged breastfeeding is the norm and infant death is the main reason for ceasing to breastfeed. Since these comments appear to hold true for the present study, and because of the difficulties of interpretation, duration of breastfeeding was excluded from the following analysis.

The remaining health-care variables which are available for both living and dead children are *ante-natal anti-tetanus immunization, ante-natal care, assistance at delivery, heard of ORT*[1], and, for Zimbabwe only, *place of delivery*. As the first three

1 DHS included a number of questions relating to knowledge and use of ORT. In most surveys, questions on use of ORT to treat recent diarrhoea episodes preceded questions on knowledge of ORT. Only mothers whose child had not been sick during the reference period, and therefore did not report using ORT, were asked if they had ever heard of it. Hence in this study the variable heard of ORT is

of these are most likely to be associated with neonatal survival, the left hand panel of Table 4.17 looks separately at neonatal deaths. The formula for the first column of the table is:

$$\frac{\text{neonatal deaths in preceding 5 years}}{\text{births in 5 years - children aged < 1 month}} \quad X \quad \frac{100}{1}$$

That is, children under age one month who were still alive at the time of the survey were excluded from the denominator, since they were still at risk of dying during the neonatal period. The right hand panel of the table considers all deaths which occurred in the five years preceding the survey, including neonatal deaths. In this panel the denominator is all births in the five-year period.

It is interesting that, of all variables for the three countries, only *ante-natal care* in Burundi and *ante-natal anti-tetanus immunization* in Uganda are significantly associated with neonatal deaths at the 95 per cent confidence level. It should be noted that in Uganda and Zimbabwe most women received ante-natal care of some sort, so the distinction is drawn between care from a trained doctor or nurse and either traditional or no care, whereas for Burundi the table refers to care from any source. One possible reason for the lack of association in all three countries could be that women who experience problems during pregnancy are more likely to seek, or to be referred to, a medical facility. Hence pregnancies which receive no attention are more likely to be free of complications, and therefore comparable in neonatal survival rates with supervised pregnancies.

The right hand panel of Table 4.17 examines all deaths in the first five years. More variables are significant, which must be attributed in part to the larger number of deaths compared with the first panel. However, it is notable that even though the variables in this table would be expected to act directly on neonatal survival, the percentages generally indicate greater differences between categories for all deaths than for deaths in the first month. This suggests that the child-care variables tend to act indirectly in association with other variables rather than directly on child survival. That is, failure to utilise modern medical care is less important as a direct determinant of neonatal survival than as a proxy for a basket of socio-economic, demographic and

computed from positive responses to any question relating to use of, recognition of packet or heard of ORT.

Table 4.17: CHILD CARE RECEIVED AND PERCENTAGE OF CHILDREN DYING IN NEONATAL PERIOD, COMPARED WITH PERCENTAGE OF CHILDREN DYING UP TO AGE 60 MONTHS: BURUNDI, UGANDA AND ZIMBABWE

	Children aged one month or more				All children aged 0-60 months			
	Neonatal Deaths %	Signif (1)		n	All Deaths %	Signif (1)		n
BURUNDI								
All children	3.3			3827	10.0			3958
Ante-natal anti-tetanus								
Yes	3.7			1522	8.5			2306
No	3.0			2306	10.7			1522
	Cramer's V=	0.02	n.s.		Cramer's V=	0.03	p=<0.05	
Ante-natal care								
Yes	2.9			3088	8.7			3088
No	4.9			767	12.1			767
	Cramer's V=	0.04	p=<0.01		Cramer's V=	0.05	p=<0.01	
Assistance at delivery								
Trained medical	4.2			742	10.6			742
Traditional, none	3.1			3112	9.1			3112
	Cramer's V=	0.03	n.s.		Cramer's V=	0.02	n.s.	
UGANDA								
All children	4.2			5030	13.3			5121
Ante-natal anti-tetanus								
Yes	3.7			2809	11.5			2809
No	5.0			2221	15.2			2221
	Cramer's V=	0.03	p=<0.05		Cramer's V=	0.05	p=<0.001	
Ante-natal care								
Trained medical	4.2			4405	13.1			4382
Traditional, none	4.3			628	13.3			651
	Cramer's V=	0.00	n.s.		Cramer's V=	0.00	n.s.	
Assistance at delivery								
No one	4.2			880	11.2			880
Trained medical	4.2			3736	13.1			1926
Traditional, other	4.7			413	13.9			2223
	Cramer's V=	0.00	n.s.		Cramer's V=	0.03	n.s.	
ZIMBABWE								
All children	2.5			3198	5.7			3380
Ante-natal anti-tetanus								
Yes	1.8			2627	4.6			2627
No	3.0			601	6.2			601
	Cramer's V=	0.03	n.s.		Cramer's V=	0.03	n.s.	
Ante-natal care								
Trained medical	2.0			3023	4.6			3023
Traditional or none	2.4			254	8.7			254
	Cramer's V=	0.00	n.s.		Cramer's V=	0.05	p=<0.01	
Assistance at delivery								
Trained medical	1.9			2297	4.0			2297
Traditional or none	2.4			980	7.0			980
	Cramer's V=	0.02	n.s.		Cramer's V=	0.07	p=<0.001	
Place of delivery								
Hospital or clinic	1.8			2054	3.9			2054
Home	2.5			1222	6.5			1222
	Cramer's V=	0.02	n.s.		Cramer's V=	0.06	p=<0.001	

(1) Significance of chi-square and Cramer's V statistics
n.s. signifies p= > 0.05

SOURCE: As for Tables 4.4, 4.5 and 4.6.

environmental factors which reduce survival chances. This is particularly evident in Zimbabwe, where each variable shows a difference of only around one percentage point for deaths in the first month, but this increases to between two and four percentage points when all deaths are considered.

This pattern also is reflected in Table 4.18, which shows the percentage dead according to whether the mother had heard of ORT. As noted previously, this variable includes all women who reported using, knowing how to mix or having heard of ORT. It was not appropriate to separate women who had used ORT from those who knew about it, as reports of use are dependent upon the child having had diarrhoea in the two weeks preceding the interview.

Table 4.18: MOTHER HEARD OF ORAL REHYDRATION THERAPY (ORT) AND PERCENTAGE OF DEATHS AMONGST CHILDREN UP TO AGE 60 MONTHS: BURUNDI, UGANDA AND ZIMBABWE

	% Dead		Signif. (1)	n
BURUNDI				
All Children	10.0			3959
Heard of ORT				
Yes	9.2			1467
No	10.5			2492
	Cramer's V=	0.02	n.s.	
UGANDA				
All children	13.3			5121
Heard of ORT				
Yes	13.1			4998
No	18.8			123
	Cramer's V=	0.03	n.s.	
ZIMBABWE				
All children	5.7			3380
Heard of ORT				
Yes	4.2			3240
No	42.1			140
	Cramer's V=	0.33	p=<0.001	

(1) Significance of chi-square and Cramer's V statistics
n.s. signifies p= > 0.05

SOURCE: As for Tables 4.4, 4.5 and 4.6.

There is a remarkable difference in survival of 37.9 per cent between Zimbabwean children whose mothers had and had not heard of ORT. However, it is unlikely that this excess mortality is entirely due to untreated diarrhoea. It is more likely that in ZDHS this variable, along with the variables in Table 4.17, operates as a proxy for other factors such as poverty, illiteracy, living in inaccessible areas, and short birth intervals. Health information is widespread among Zimbabwe women, and it can be surmised that the few who had not heard of ORT would be exceptionally underprivileged. This is probably also true of Uganda, although the difference in survival between the two groups is less.

Only 37 per cent of Burundais children had mothers who had used or heard of ORT, and the difference in their survival is not significant. This reflects poorer access to, and lower utilization of, health services in this country, compared with Uganda and Zimbabwe. As a consequence, the proxy effect of this variable is not apparent in Burundi.

4.4 MULTI-VARIATE ANALYSIS

When sampled children are of differing ages, it is essential that any multi-variate analysis of factors associated with their survival status incorporates controls for censoring. Cox's regression was, therefore, selected for this analysis, since it accommodates censoring by using a survival approach. This method treats age of survivors, or age at death of children who die, as a time variable. The analysis comprises a series of computations, one for each unit of time, which in this instance is each month of age. Cases are deleted from the analysis as it reaches their age when surveyed, or age at death, until the maximum age in the sample is reached and all cases have been analysed. That is, all cases with ages less than the maximum age are progressively removed from the analysis, and hence from the denominator, at the point where they are no longer exposed to the risk of dying. This procedure allows comparison of the relative risk of death of children with various characteristics, without bias due to censoring.

All variables from Tables 4.4 to 4.12 and 4.17 which were significant at the 95 per cent level of confidence of higher were tested for inclusion in the model. Where variables were highly correlated, the variable with the highest level of significance was selected. Multiple births were retained in the analysis, with single or multiple birth treated as a dichotomous variable. The categories for each variable were generally the same as in Tables 4.4 to 4.15 and 4.17. The category with the largest number of cases was always treated as the reference category, in order to minimise standard error estimates and to simplify the interpretation of odds. Table 4.19 lists the variables tested for inclusion in the model and their reference categories. It should be noted that the reference category for some variables, such as *education*, varies between countries.

Table 4.19: BASE CATEGORIES FOR COX'S REGRESSION

VARIABLE NAME	BURUNDI	UGANDA	ZIMBABWE
Child's age	*Interval*	*Interval*	*Interval*
Ante-natal anti-tetanus	Yes	Yes	Yes
Ante-natal care	No	Yes	Yes
Dead sibling	No	No	No
Birth order	*Interval*	*Interval*	*Interval*
Sex of child	Male	Male	Male
Mother's age	*Interval*	*Interval*	*Interval*
Births in last 5 years	*Interval*	*Interval*	*Interval*
Single or multiple birth	Single	Single	Single
Region	Central Plateau	South West	Manicaland
Residence	Rural	Rural	Rural
Mother's education	None	-	-
Mother's literacy	-	No or weak	Reads
Husband's education	None	-	Primary
Husband's literacy	-	Reads	-
Husband's occupation	Agriculture	Agriculture	Manufacturing
Electricity	No	No	No
Water source	Well	Well or bore	Bore
Distance to water	*Interval*	< .25 mile	.1-1 km
Toilet facility	Pit latrine	Pit latrine	None
Number in household	*Interval*	*Interval*	*Interval*
Number of other wives	-	*Interval*	-
Language	-	-	Shona
Strata	-	-	Communal
Religion	-	Catholic	Christian

The Cox's regression procedure requires valid responses for all variables included in the model, and drops from the analysis any cases with missing values. In order to avoid undue reduction of the sample because of large numbers of missing cases, those variables with most missing cases, *preceding* and *succeeding birth interval*, were treated as categorical variables with four categories: *no preceding/succeeding birth interval; less than 24 months; 24-35 months; and 36 months or more.* For *preceding birth interval* the reference category was *24-35 months* in each country, while for *succeeding birth interval* it was *no succeeding birth interval.* Table 4.19 lists the variables tested for inclusion in the model and their reference categories. It should be noted that the reference category for some variables, such as *education*, varies between countries.

Table 4.20 presents the final models derived from the analysis for each country. Only variables which were significant at the 95 per cent level of confidence were retained in the models. Their relationship with the probability of having died is expressed as odds, relative to the reference category. That is, the base odds for all interval variables and for the reference category for each categorical variable were set at one. The odds for the highest value for each interval variable and the remaining categories for each categorical variable are expressed relative to the base category.

The appearance of both *births in the last five years* and *succeeding birth interval* in all three models reflects the patterns noted above. Again it must be noted that short birth intervals may be both a cause and a consequence of child mortality and higher numbers of births. However, the appearance of *dead sibling* as a separate, significant variable in the models for Burundi and Uganda, with substantially different odds from *succeeding birth interval* and *births in the last five years*, indicates that the replacement effect does not explain all of the increased risk. Clearly there is also an increased risk of death due to maternal factors and/or competition from older and younger siblings in these countries. The replacement effect could be greater in Zimbabwe, where the effect of *dead sibling* is less significant than *births in the last five years* and *succeeding birth interval. Birth order* appeared in the model for Burundi, with higher birth orders having a slightly increased risk of dying. Female children have a higher risk of death than male children in Zimbabwe.

A striking feature of Table 4.20 is that all of the variables appearing in the models are demographic variables, or the related environmental variable, *number in household.* The stronger effects of these variables excluded socio-economic and other environmental variables from the final models. Most of the demographic variables in the models suggest an effect of maternal depletion as a result of a rapid pace of childbearing, and the side effect of competition from siblings.

Table 4.20: RELATIVE ODDS OF DYING, CHILDREN UP TO AGE 60 MONTHS: BURUNDI, UGANDA AND ZIMBABWE

	B	Signif.	Odds
BURUNDI			
Births in last 5 yrs	1.6325	0.0000	5.12
Birth order	0.2036	0.0000	1.23
Dead sibling	-0.4884	0.0000	0.61
Number in household	-0.1505	0.0000	0.86
Succeeding birth interval			
None			1.00
Less than 24 months	0.9332	0.0000	2.54
24-35 months	0.3372	0.0179	1.40
36 months +	-0.6180	0.0090	0.54
UGANDA			
Births in last 5 yrs	0.4328	0.0000	1.54
Dead sibling	2.1373	0.0000	8.48
Succeeding birth interval			
None			1.00
Less than 24 months	0.6950	0.0000	2.00
24-35 months	-0.2462	0.0008	0.78
36 months +	-0.0813	0.4673	0.92
ZIMBABWE			
Births in last 5 yrs	1.1041	0.0000	3.02
Succeeding birth interval			
None			1.00
Less than 24 months	0.9903	0.1170	2.69
24-35 months	0.1594	0.0000	1.17
36 months +	-0.7632	0.0856	0.47
Female child	0.2440	0.0502	1.28

SOURCE: As for Tables 4.4, 4.5 and 4.6.

The importance of demographic factors in the models for the three countries is partly a reflection of the bias towards infant deaths in the five years preceding the surveys. As shown in Tables 4.13, 4.14 and 4.15, at least 60 per cent of deaths up to age 60 months in each country occurred during infancy, when they are more likely to be caused by maternal factors. Hence the predominance of demographic factors is expected, and is consistent with much of the literature on child survival discussed in

Chapter Two. The implications of this pattern for health and nutrition policies will be discussed in later chapters.

4.5 BIRTHWEIGHT

DHS did not collect birthweights in Burundi and Uganda, but in Zimbabwe birthweights were copied from the health cards of 1426 children, that is, 45.7 per cent of surveyed living children aged five years and under. Unfortunately, these data do not support an assessment of the contribution of low birthweight to infant and child mortality. First, no birthweights were recorded for dead children. This means that the birthweight data are inevitably censored by deaths of some children with low or very low birthweights which occurred before the survey. The absence of data on dead children also prevents comparison of the probabilities of dying of children with normal birthweight with those with low birthweight.

Second, birthweights were available only on some of the health cards inspected by interviewers. No birthweights were collected from the 6 per cent of all surveyed children who did not have a health card, the 5 per cent who were alive but did not respond to the question on possession of a health card, or the 18 per cent whose health card was not shown to the interviewer. It is also obvious that birthweights were available only for those children who attended a health facility at birth. Hence the sample is biased towards children whose mothers made greater use of health facilities.

Table 4.21 compares the characteristics of children for whom birthweights were recorded with those of all surveyed children. It can be seen that a higher percentage of children with birthweight data had secondary educated and urbanized mothers, and a slightly higher percentage were multiple births. A slightly lower percentage had mothers aged 15-19 years. Low birthweight often is associated with very young maternal age and primiparity (WHO, 1992b: 3). Hence the higher socio-economic status and better health care of educated and urban mothers, and the slight bias towards mothers in their twenties in this sample, would be expected to produce fewer cases of low birthweight than for the country as a whole.

In 1976 the WHO defined low birthweight (LBW) as 'less than 2500 gms, i.e. up to and including 2499 gms' (WHO, 1992b: 1). This is a conservative definition, as there is a tendency for those health professionals who use only simple equipment to round

Table 4.21: DISTRIBUTION OF CHARACTERISTICS OF CHILDREN WITH BIRTHWEIGHTS COMPARED WITH ALL SURVEYED CHILDREN: ZIMBABWE

	All Children		Children with birthweight	
	%	Number	%	Number
Type of birth				
Single	96.5	(3074)	96.0	(1369)
Multiple	3.5	(112)	4.0	(57)
Total	100.0	(3186)	100.0	(1426)
Sex				
Male	50.0	(1592)	50.1	(715)
Female	50.0	(1594)	49.9	(711)
Total	100.0	(3186)	100.0	(1426)
Child's age (months)				
3-12	20.0	(636)	28.2	(402)
13-24	20.0	(636)	22.9	(326)
25-36	20.2	(642)	21.0	(300)
37-48	18.5	(591)	14.3	(204)
49-60	21.4	(681)	13.6	(194)
Total	100.0	(3186)	100.0	(1426)
Mother's age (years)				
15-19	12.4	(395)	11.3	(161)
20-24	29.3	(932)	32.6	(465)
25-29	24.5	(780)	23.7	(338)
30-34	18.5	(589)	18.4	(263)
35-39	10.7	(343)	10.0	(143)
40-44	3.5	(112)	3.4	(48)
45-49	1.1	(35)	0.6	(8)
Total	100.0	(3186)	100.0	(1426)
Region				
Manicaland	13.5	(431)	10.2	(145)
Mash Central	7.4	(237)	7.3	(104)
Mash East	13.5	(429)	14.2	(204)
Mash West	12.0	(382)	12.0	(171)
Mat North	5.0	(158)	4.3	(61)
Mat South	7.1	(226)	7.5	(107)
Midlands	15.2	(483)	15.3	(218)
Masvingo	12.3	(391)	12.8	(183)
Harare/Chit.	6.7	(215)	7.6	(108)
Bulawayo	7.3	(234)	8.8	(125)
Total	100.0	(3186)	100.0	(1426)
Residence				
Urban	26.6	(847)	34.3	(489)
Rural	73.4	(2339)	65.7	(937)
Total	100.0	(3186)	100.0	(1426)
Mother's education				
None	18.0	(577)	13.3	(189)
Primary	63.4	(2019)	62.9	(897)
Secondary +	18.6	(590)	23.8	(340)
Total	100.0	(3186)	100.0	(1426)

SOURCE: As for Table 4.6

off weights. Many data sets show heaping of values at 2500 gms. If the WHO definition is strictly adhered to, only 9.1 per cent of cases in the ZDHS would be classified as having LBW, but the inclusion of the 29 cases reported as exactly 2500 gms increases the percentage to 11.1.

The WHO conceded that 'for clinical purposes individual countries often choose alternative cut-off values' (WHO, 1992b: 1). As ZDHS birthweights were copied from health cards, they are assumed to be highly subject to rounding, unlike data collected primarily for research purposes. LBW has therefore been defined as 'up to and including 2500 gms' in this analysis. Very low birthweight will be considered as 1500 gms and under. In ZDHS only 158 cases weighed 2500 gms or less, of which only nine were 1500 gms or less.

Zimbabwean children for whom birthweights were not recorded probably received less health care than others, as the most likely reason for the absence of a birthweight is that their health card was not readily available. This is likely to be associated with factors which increase the risk of LBW, such as low socio-economic status, and poor maternal health and nutrition. Hence, although birthweights of 2500 gms or less comprise 11.1 per cent of those in the survey, it is probable that the percentage would have been higher had birthweights been recorded for all children. WHO (1992b: 5) estimates that 14 per cent of Zimbabwean children have LBW. This compares unfavourably with 10 per cent for Uganda (WHO, 1990: 35), and 13.5 per cent for Burundi (WHO, 1992b: 22), although WHO (1990: 35) estimates 18 per cent for Burundi. Given the likely bias of the ZDHS birthweight sample, 14 per cent would seem to be a plausible estimate for all Zimbabwean children surveyed by DHS.

Tables 4.22 shows the percentages weighing 2500 gms or less at birth, according to those socio-economic, demographic and environmental characteristics which were significant at the 95 per cent level or higher. Only *ante-natal anti-tetanus* and *multiple birth* have a highly significant relationship with LBW. As in Table 4.17, *ante-natal anti-tetanus* is presumably acting as a proxy for health education and generally good health care practices.

Multiple birth, dead sibling, births in the past five years, drinking water source, ante-natal anti-tetanus, mother's and *husband's literacy* are all significantly associated with LBW in the expected direction. Again, this group of variables can be interpreted as

Table 4.22: CHARACTERISTICS OF CHILDREN WITH LOW BIRTHWEIGHT: ZIMBABWE (per cent)

	% LBW	Signif. (1)	n
All measured children	11.1		1426
Ante-natal anti-tetanus			
Yes	9.8		1233
No	18.8		170
	Cramer's V=	0.09 p=<0.001	
Dead sibling			
No	10.1		1118
Yes	14.6		308
	Cramer's V=	0.06 p=<0.05	
Multiple birth			
No	8.8		1369
Yes	64.9		57
	Cramer's V=	0.35 p=<0.001	
Births in past 5 yrs			
1	9.9		605
2	10.6		679
3+	18.3		142
	Cramer's V=	0.08 p=<0.05	
No. in household			
1-6	9.3		642
7-10	10.9		567
11+	16.6		217
	Cramer's V=	0.08 p=<0.05	
Drinking water source			
Well or bore	12.4		638
Piped to house	8.6		440
Outside tap	15.1		199
Surface,other	7.4		149
	Cramer's V=	0.08 p=<0.05	
Mother's education			
None	9.5		897
Primary	12.6		340
Secondary +	15.9		189
	Cramer's V=	0.07 p=<0.05	
Mother's literacy			
Reads	10.3		1179
Cannot Read	15.0		247
	Cramer's V=	0.06 p=<0.05	
Husband's literacy			
Reads	10.4		1278
Cannot Read	20.7		87
	Cramer's V=	0.08 p=<0.01	

(1) Significance of chi-square and Cramer's V statistics.

SOURCE: As for Table 4.6.

indicators of higher socio-economic status and better health-care practices. The low proportion of LBWs among those drinking surface water is probably a random effect due to the small number of cases in this category, as these cases would be expected to be those living in less privileged areas.

Mothers with no education had a higher percentage of LBWs than both primary and secondary educated mothers, but those with secondary education had a higher percentage than the primary educated group. This is probably an aberration due to the small number of cases. Larger households were associated with higher percentages of LBWs. Variables which were not significant at the 95 per cent level included *mother's age at birth, place of residence, place of delivery, electricity, region,* and *strata* or *language*. This is probably due to the bias of the sample towards children receiving better health care, rather than to the absence of any real difference at the national level. However, these results are consistent with the findings of Ebomoyi, Adetoro and Wickremasinghe (1991). Their analysis of the relationship of social and biological characteristics with birthweight in Ilorin, Nigeria, indicated that the significant factors were mother's weight, height, age, education and ethnicity, and child's sex.

Although Table 4.22 points towards factors that may be associated with birthweights of 2500 gms or less, this sample of birthweights does not support further analysis. As discussed above, it is apparently biased towards children receiving better care, and almost certainly towards heavier children, as shown by the low proportion of LBWs compared with national estimates. It would therefore be invalid to use this sample to draw wider conclusions about the correlates of LBW, and no multi-variate analysis will be attempted here. Chapter Seven explores the extent to which low growth attainment, LBW and deaths cluster in households.

4.6 DISCUSSION

The preceding analysis reflects the declines in mortality reported for East and Central Africa since the early 1970s, as discussed in Section 4.2. Estimates derived from the three DHS surveys, presented in Table 4.1, 4.2 and 4.3, indicate a decline in both infant and child mortality in Burundi, a small decline in infant mortality offset by a small increase in child mortality in Uganda, and a decline in child mortality in Zimbabwe. In the five years preceding interview in the three countries both infant and child mortality rates were highest in Uganda and lowest in Zimbabwe.

The preliminary bi-variate analysis indicates that demographic factors tend to have more significant and stronger relationships with child survival than either socio-economic or environmental factors, with the exception of ***number in household.*** This is consistent with the results of several other studies. Aly (1990) found that demographic variables were more important than socio-economic and environmental variables in his analysis of WFS data for Egypt. Similarly, Gubhaju, Streatfield and Majumder (1991) found demographic variables were the predominant determinants of infant mortality in Nepal, and Hull and Gubhaju (1986) reached a similar conclusion regarding infant and child mortality in Java and Bali. Although Vella et al. (1992) found that socio-economic variables were significant predictors of mortality in South West Uganda, it seems that the only demographic variables available for their analysis were age of child and birth order.

The bi-variate analysis of age at death shows a shift over time towards increasing proportions of neonatal deaths as overall mortality declines. This is consistent with the importance of demographic factors, which are more likely to affect neonatal deaths than deaths at older ages. Kim (1988) argued on the basis of his Korean study that increasing development and urbanization initially reduce the importance of demographic factors and increase the importance of socio-economic factors as determinants of infant and child mortality. Although socio-economic differences eventually tend to become the only important influences on child mortality, the effect of demographic factors on infant mortality remains (Kim, 1988: 353). The shift towards a relative increase in the importance of demographic factors in Zimbabwe appears to reflect this pattern, although the cause is more a consequence of efficient health services than increasing living standards.

A notable feature of the foregoing analysis is that in Zimbabwe, the most developed country with the lowest mortality rates, there is a clustering of factors generally indicating a better child-rearing environment. These are educated mothers, good water and sanitation, electricity, urban environment, husband with a professional or technical job, and, most important, a small number of births in the preceding five years and long birth intervals. The patterns are less consistent for Burundi and Uganda where the percentages dying are higher and fewer people have these optimum characteristics.

The patterns for the child-care variables in Tables 4.17 and 4.18 are unexpected in view of the importance generally attached to them. In these data sets they appear to have an indirect rather than the expected direct effect on infant mortality. However, it would be unwise to draw any firm conclusions from this pattern, as the questions on child care are not very detailed. It suggests a need for further research on the relationship of child care variables to infant mortality in these countries.

Figures 4.1 to 4.21 exhibit marked variations in the survival probabilities of children with different characteristics. The survival approach, which controls for censoring of cases no longer exposed to the risk of death, demonstrated that the differences apparent in the cross-tabulations persisted. Most apparent are lower probabilities for multiple births, those with short birth intervals and those with more competing siblings.

Although Figures 4.1 to 4.21 provide very convincing evidence of the importance of demographic variables, they are based on bi-variate analysis, and further exploration was necessary to distinguish variables with the strongest effects. Cox's regression was used to build models of the variables with the strongest effects, while controlling for the effect of censoring.

The results, shown in Table 4.20, confirm the predominance of demographic variables. In particular, short preceding birth intervals and a greater number of births in the preceding five years dramatically increase the odds of dying. Although this is partially a reflection of the replacement effect, there is also evidence of a direct impact of short birth intervals. This is consistent with the literature, discussed in Chapter Two, especially studies by Hobcraft, McDonald and Rutstein, (1983 and 1985); Cleland and Sathar, (1984) and Majumder, (1989). They pointed out that short birth intervals act on infants by increasing the risk of poor nurturing due to maternal depletion, and on children by increasing competition from siblings.

The higher mortality risk associated with short birth intervals in the present study also is related to the status of women and to poverty. In Burundi, Uganda and Zimbabwe, women who lack education, and hence opportunities for paid employment, tend to have a subordinate role in marriage. Fathering a child brings status to men, and this tends to be particularly important to men who, themselves, lack education. Such men may perceive their partners primarily as childbearers. Frequent childbearing, and consequent short birth intervals, are thus related to low education levels.

Families where education levels are low tend also to be poor, and often lack the resources to give proper care to children. Various women the writer interviewed in Uganda and Zimbabwe commented that some husbands would go away from their families for weeks or months at a time, or would spend household resources on beer drinking and girlfriends, even though their wives were burdened with frequent pregnancies and large families. They said this was especially common in disadvantaged families. This reflects the greater freedom of men to find temporary escapes from miserable living conditions. Such activities strain household resources and tend to further disadvantage closely spaced children. Children in these families thus suffer not only from the direct effects of short birth intervals, but also from the disadvantages of poverty.

It is thus apparent that, although the most important direct determinants of child mortality risk are birth intervals and the number of competing siblings, socio-economic and environmental factors interact with demographic factors, as depicted in Figures 1.3 and 1.4. These models are, therefore, a more realistic representation of the processes in the three study countries than those which classify socio-economic factors as underlying other groups of factors.

Only limited analysis was possible with the small and biased sample of birthweights for Zimbabwe. However, it is apparent that LBW generally shows the same pattern of association with demographic, socio-economic and environmental factors. It seems likely that, if suitable data were available, a multi-variate analysis of the factors associated with LBW in the three countries would produce models similar to those for mortality.

As stated in Chapter One, a major objective of this study is to compare the correlates of mortality and LBWs. However, before a meaningful comparison can be made it is necessary to consider the overall patterns of child growth attainment in the three study countries. Chapter Five examines the anthropometric data in the three data sets and explores patterns of growth attainment by age and sex, in order to provide a background to Chapter Six, which comprises an analysis of the correlates or poor growth attainment.

CHAPTER FIVE: ANTHROPOMETRIC PATTERNS OF CHILDREN AGED FIVE YEARS AND UNDER

...anthropometry is the single most portable, easily applied, inexpensive and non-invasive method of assessing body composition, which reflects both health and nutrition, and predicts performance, health and survival. (Dr Fernando Antezana, Assistant Director General of WHO, 12 November, 1993, reported in *SCN News*, No. 10: 28).

5.1 INTRODUCTION

Anthropometry can be defined as 'the technique of expressing quantitatively the form of the body' (Cameron, 1986: 3). The earliest recorded longitudinal study of child growth was that of Count Philibert Gueneau de Montbeillard, who monitored the growth of his son between 1759 and 1777 (Cameron, 1986: 4). Since then many more studies have provided data on patterns of child growth over time.

In recent years the practice of weighing and measuring children has become a popular technique for monitoring individual growth attainment and population health. Data on height and weight are most commonly collected longitudinally over time, such as during a series of visits to a health facility, but, in some cases, one-off measurements may be obtained by a survey or other data gathering exercise.

When height and weight are related to exact age, they measure growth attainment. However, there has been much debate about appropriate standards for growth attainment of children, and about the interpretation of anthropometric data. Child growth is determined primarily by genetic potential, food intake and the experience of infection, and also may be affected by other factors, such as stress and exercise levels (Ferro-Luzzi, 1984; Mata, 1985: 165; Nutrition Reviews, 1988: 217; Tomkins and Watson, 1989: 30). Ebrahim (1978a: 7) includes among the causes of short stature: hereditary short stature, congenital dwarfism, chromosomal disorders, inter-uterine growth retardation, malnutrition, hormonal deficiencies and chronic diseases. The complex interaction of determinants makes it difficult to predict growth attainment with any precision, and difficult to assess the relative contribution of various factors to growth attainment at any given point in time.

The DHS data sets upon which this study is based provide a one-off, cross-sectional snapshot of the height and weight of children in the survey. This chapter begins with a description of the anthropometric indices commonly derived from such data and then reviews the literature on their interpretation. The second part of the chapter describes and interprets the anthropometric patterns depicted in the three data sets. This provides a foundation for the analysis of the correlates of growth attainment in Chapter Six.

5.2 THE MEASUREMENT OF CHILD GROWTH

Genetic variation in size between children of the same age is expected within any population (Mora, 1985: 270). Provided the sample size is large enough, there is usually a normal distribution of height and weight across samples of children of any given age. Within any given population, healthy children of different ages are expected to be of different sizes, and also some variation is expected between children of the same age. At the same time, all healthy children are expected to progressively increase in dimensions and weight until they reach adulthood. In order to compare the growth attainment of children of different ages it is necessary to use age standardized indices. These values are usually presented as a range for each age rather than as a single value, which allows for the expected differences in growth attainment within a population.

There are many possible measurements that can be taken from the human body. However, the collection of comprehensive, precise measurements requires high levels of skill and complex scientific equipment (see, for example, Cameron, 1986). Further, the utility of particular measurements and the number of measurements required depends upon the age of the subject, and the purpose for which the measurements are intended. The most common practice in anthropometric studies of children up to five years of age is to measure height (or length of children up to age two years) and weight, and perhaps also head circumference, upper arm circumference and skinfold thickness. These measurements are then compared with the expected range of measurements for children of the same age.

The anthropometric indices used most commonly for children are height-for-age (Ht/A), weight-for-age (Wt/A), weight-for-height (Wt/Ht)[1], Head Circumference (HC), Mid

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1 DHS survey staff measured children up to two years of age by placing them in a supine position against a measuring board, thus measuring their length. Older children stood upright so that their height was measured rather than their length. For simplicity this study will refer to the 'height-for-age' (Ht/A) and 'weight-for-height' (Wt/Ht) of children of all ages, in preference to the more precise but cumbersome use of 'length-for-age' or 'weight-for-length' for those up to two years of age and 'height-for-age' and 'weight-for-height' only for older children. Where reference is made to other studies which use the term 'length', the words 'height' and 'length' should be considered interchangeable. Similarly, where reference is made to studies which use the term 'stature', the words 'stature' and 'height' should be considered interchangeable.

Upper Arm Circumference (MUAC) and Skinfold Thickness (SFT). Other researchers are exploring the utility in child anthropometry of Body Mass Index (BMI), which in the past has been used mainly as an indicator of adult nutrition (Kogi-Makau, 1988: 48; K.V.Bailey, personal communication). Although all indices except BMI are normally related to age, Wt/Ht can be used independently of age (Zerfas et al., 1986: 477).

MUAC was first used as a criterion for including children under five in food supplementation programmes in the Biafran war (Ebrahim, 1983: 111), and is now used widely for this purpose, including in Zimbabwe (Zimbabwe Ministry of Health, 1992). Normally, children whose MUAC is 12.5 cm or less are considered malnourished. Since the average MUAC of normal children increases by only one centimetre between ages one and five years (Ebrahim, 1983: 111), this indicator was also commonly used without reference to age, following early endorsements of the practice by researchers such as Jelliffe and Jelliffe (1971). More recently, Alam, Wojtyniak and Rahaman (1989) compared five indicators: MUAC, arm circumference-for-height, Wt/A, Ht/A and Wt/Ht, and concluded that MUAC performed best as a predictor of mortality.

However, when a single cut-off is used, the positive link between MUAC and mortality can be explained by the automatic selection of younger children, who have higher mortality rates. Some nutritionists consider that MUAC is a good indicator only when separate cut-offs are used for small age ranges: three month intervals for up to one year, and one-year intervals for ages one to five years. This requires a measuring arm band with eight different points, which must be related to age, and makes measurement a complex exercise for field workers (K.V.Bailey, personal communication).

DHS measured the height and weight of eligible children in each sample population and used the World Health Organization / National Center for Health Statistics / Center for Disease Control (WHO/NCHS/CDC) reference data for the calculation of indices, as recommended by Waterlow et al. (1977: 490). These data were compiled during the 1970s by the NCHS. The full set of WHO/NCHS/CDC reference tables comprise weight by age, stature by age, weight by stature, head circumference and limb circumference. The WHO/NCHS/CDC tables present values for every 10th centile, and for the 3rd, 5th, 95th and 97th centiles for each month of age, up to 18 years and separately for each sex (WHO, 1983).

However, these tables provide no data for monitoring the growth of children situated above the 97th centile, or below the 3rd centile. For example, many children from poor families in developing countries are below the 3rd centile (Dibley et al., 1987a: 737).

Moreover, the implications of different growth attainment varies between age groups. For example, 60 per cent of median Wt/A is a more serious condition amongst young children than for school age children. To overcome these problems the growth reference curves were transformed into age-standardized normalized growth curves based on standard deviations (SDs). These indices, also known as Z-scores, have been used widely since 1978 (Dibley et al., 1987a: 737-738).

Even if Z-scores are used, the reference values still have some peculiarities. Measurements for the WHO/NCHS/CDC reference population were drawn from two different child populations in the United States of America. Measurements for children aged 0-36 months came from studies of the Fels Research Institute, Yellow Springs, Ohio, and those for 2-18 years from NCHS national samples (WHO, 1983: 61-62). Dibley et al. (1987b) pointed out that the combination of these two samples has resulted in disjunction at age 24 months, with the Fels children showing higher medians and lower variances. The problem is exacerbated by the use of a mixture of lying and standing measurements of stature in the NCHS data. This disjunction manifests as a sharp artifactual drop in the prevalence of stunting and wasting after 24 months of age, which is more pronounced among more malnourished populations. However, Pelletier (1991: 1078) judged this to be of no consequence for analysing cross-sectional data, or for comparing trends over time, as long as the same reference values are applied uniformly, and age composition is taken into account.

Another consideration is that the WHO/NCHS/CDC reference data were drawn from a developed country, in which the population was reasonably well nourished. Many samples from developing countries are less well nourished, with the majority of children falling below the mean attainment at each age of the reference population. Again, this is not a limitation if the reference median is used correctly. That is, it should be treated as a yardstick against which studied populations can be compared, not as an ideal growth target which all children should be expected to achieve (Waterlow et al., 1977: 490; Tanner, 1986: 96). Given that usually it is impractical to develop a local standard, it has become common practice to use the reference values from another population as a point for comparison of measurements made at different times and/or in different places, (Anderson and Gracey, 1985: 68; Gabr, 1985:69).

Even if the reference population is treated as no more than a yardstick, it is important to note that, while most of the values in the WHO/NCHS/CDC reference population were based on observed data, the two outer centiles were estimated (WHO, 1983: 61). This means that these data do not supply observed reference values for heights and weights below the 10th centile or above the 90th centile, which are approximately equivalent to minus and plus 1.3 SDs. It is thus possible that the WHO/NCHS/CDC distributions for children at the outer limits of the reference values do not reflect reality. While this may be of little consequence for well-nourished populations, it could impair the utility of the reference values in countries such as Burundi, Uganda and Zimbabwe, where many children cluster at the lower extremes of the Ht/A and Wt/A reference tables.

Despite these limitations, the WHO/NCHS/CDC reference values are well known and widely used, and will be used for this analysis. As DHS measured only height and weight of eligible children, only Ht/A, Wt/A and Wt/Ht are included in the analysis. However, these indicators are the preferred measures for evaluating the impact of nutritional programs (WHO, 1983: 11, WHO, 1986: 937). They are also appropriate for studies which seek to relate growth attainment to socio-economic characteristics and other determinants.

5.2.1 Interpretation of anthropometric indices

Although the methodology of anthropometry is well established, there is some disagreement on its interpretation. Perhaps because anthropometric indices are such a convenient way of describing and comparing growth attainment, there is sometimes a tendency to misstate their implications for health. Beaton et al. (1990: 1) highlighted this issue in the following extract from the Introduction to their guide on appropriate uses of anthropometry:

> *The use and interpretation of anthropometry in various operational settings has been a matter of much debate in recent years. In part, this has been conceptual, arising from a need to distinguish growth failure - measured by weight and/or length - and nutritional status. There has been a tendency to equate smallness with malnutrition. As Beaton (1989) remarks by way of illustrating the development of this misconception 'Small size has changed from being a predictor of an undesirable health outcome (severe malnutrition and clinical complications) to being the undesirable outcome...Small size and "malnutrition" became synonyms'.*

Even though it should not be concluded that small size is in itself an indicator of malnutrition, it is well known that deficiencies in nutrition at different points can affect height and weight attainment (Waterlow et al., 1977; Ebrahim, 1983; WHO, 1983: 26). Moreover, height and weight are affected in different ways. On one hand, weight is very sensitive to short-term changes in food intake and fluid balance. Weight may fluctuate perceptibly from one day to another, and change substantially in a few weeks. Previously malnourished children can catch up and gain weight at 10 to 20 times the normal rate of growth if adequately nourished (Royer and Waterlow, 1985: 63). On the other hand, height is unlikely to be affected in the short-term, but may be retarded if nutritional deficiencies persist during critical growth periods. Although increases in height may be slowed by poor nutrition and infection, children do not lose height.

As a consequence of the different impact of nutritional deficiencies on height and weight, the interpretation of the anthropometric indicators varies. Children with low Ht/A are said to be stunted. Low Ht/A generally indicates long-term past malnutrition over a period of months, especially before age two years. Height deficiencies are usually related to intermittent or continuous inadequate nutritional intake and/or frequent infection, especially during the first two years of life (Graitcer et al., 1981: 292). Low Ht/A is therefore considered a good indicator of chronic malnutrition. It must be noted, however, that some researchers have suggested that stunting could be a useful and normal adaptation to food scarcity (Royer and Waterlow, 1985: 64; Mora, 1985: 270). A stunted child requires less energy to maintain its smaller stature, so is more likely to survive. However, Gopalan (1988: 270) argued that to regard this as 'normal functioning' is to overlook the opportunity cost to that individual as a result of stunting.

Low Wt/A is associated with current or acute malnutrition or infection. A child who has previously received adequate nutrition, but is currently experiencing a short-term episode of reduced food intake or infection, would typically have normal Ht/A and low Wt/A. When used on its own, Wt/A is a better indicator for children up to age one year than for older children. This is because weight is obviously related to height. After the first year of life stunting could manifest, thus impairing the reliability of Wt/A as an indicator of acute malnutrition. Older children who have low Ht/A would also tend to have low Wt/A, even if they are not currently malnourished. In this case, if only one cross-sectional measurement is available, Wt/A alone does not distinguish acute (short-term) malnutrition from low weight associated with smallness of stature.

Moreover, because of the volatility of weight in the short-term, Wt/A does not distinguish between acute and chronic (long-term) malnutrition (Waterlow et al., 1977: 491). This limitation of Wt/A applies particularly to cross-sectional data, but less to longitudinal surveys, where repeated measurements are taken and trends can be observed.

Wt/Ht is a more robust indicator, particularly for cross-sectional data. It is relatively independent of age, and allows for stunting. Low Wt/Ht, or wasting, is considered the best indicator of present malnutrition. Between one and 10 years, Wt/Ht is nearly independent of age. However, when children of the same height who are aged less than one year are compared, the older child tends to be heavier (Waterlow et al., 1977: 491).

Despite these recognized patterns, the interpretation of anthropometric data is complex, because growth is determined by many factors, while anthropometric indices are simply measures of growth attainment. Dowler et al. (1982: 103) commented:

> *...anthropometric indicators are commonly used as proxies for 'nutritional status', an imprecise notion that covers the outcomes of a wide range of different processes, including the effects of different nutrient deficiencies and of non-nutritional factors such as infection.*

The exact nature of the interaction of the factors that determine growth, and the causes of growth, are still imperfectly understood.

A further complication is that while anthropometry measures growth attainment, it is not the only measure. Growth can be defined as ' the progressive development or increase in size of a living thing' with general body growth 'the increase in the physical size of the body and increase in the total weight of the muscles and various internal organs' (Taber, 1985: 710). But although increases in size are one component, growth also includes changes in the functions and specialization of various parts of the body, as well as alterations in the form of the body (Sinclair, 1989: 1). Such changes are not detected by anthropometry, but do have implications for health.

Good nutrition requires both macro-nutrients and micro-nutrients (Ramalingaswami, 1991: 2; FAO/WHO, 1992). A balanced food intake is required to ensure good growth. An adequate caloric intake which is deficient in essential micro-nutrients, particularly iron and Vitamin A, may prevent the realization of growth potential. An extreme example is the condition myxoedematous cretinism, resulting from iodine deficiency, which can cause severe growth retardation, as well as impairment of normal body functions (Hetzel, 1989).

Another consideration is that growth velocities are not constant. Although the general pattern is rapid growth in infancy followed by a gradual decrease in velocity (see Tanner, 1978; Brandt, 1984), Falkner (1985: 124) observes that to think of infant growth as

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Another consideration is that growth velocities are not constant. Although the general pattern is rapid growth in infancy followed by a gradual decrease in velocity (see Tanner, 1978; Brandt, 1984), Falkner (1985: 124) observes that to think of infant growth as children were able to catch up growth in height between episodes of diarrhoea. Hansen et al. (1971) found that of a group of children who had been severely stunted at ages between one and four years, half or more were still below the normal range 10 years later. Nabarro et al. (1988: 177) hypothesized from their research in Nepal that the length of time a child remains below expected Wt/Ht determines the rate of subsequent catch-up linear growth. They point out that this could explain the association of poverty and stunting, since poor families are less able to ensure rapid catch-up growth after periods of infection.

However, Royer and Waterlow (1985: 64) commented that the causal relationship between nutritional deficiency and physical retardation is not fully understood. Indeed, the findings of studies which explore the relationship between nutrition and physical and mental development are often inconsistent. For example, Hansen et al. (1971: 308) found no evidence that a single episode of kwashiorkor had a permanent retarding effect on intelligence. Similarly, Bejar (1981) found no evidence of an association between cognitive development and nutrition. However, FAO/WHO (1992: 25) refer to a 20-year follow-up study which found evidence of impaired motor function and early, irreversible damage to intellectual development, as a result of sustained malnutrition. Correa (1975: 30) and Popkin and Lim-Ybanez (1982: 59) considered the relationship between nutrition, particularly haemoglobin levels, and learning ability so clear that they advocated investment in improving nutrition as a possible complementary allocation of educational resources. Spurr, Reina and Barac-Nieto (1983) reported that marginally malnourished children have significantly depressed work capacity and productivity as adults, due to small stature and reduced lean body mass.

From the above discussion it can be seen that, although low Wt/A, Ht/A and Wt/Ht are usually associated with particular patterns of nutritional deprivation, and although nutrition has the greatest influence on growth, growth attainment always must be considered as the product of a combination of factors, including infection, which is discussed further in Section 5.2.3. Children whose score for any of the indicators is substantially below the mean attainment in their population have almost certainly experienced not only poor nutrition, but also repeated infection and possibly other forms of deprivation.

5.2.2 Limitations of cross-sectional anthropometry

One-time, cross-sectional surveys of children's anthropometric status are an attractive method of collecting data, because they are relatively cheap and easily organized compared with longitudinal studies (WHO, 1983: 17; Falkner, 1985: 123). However, since there is no subsequent measurement of the same sample, only limited conclusions can be drawn from them. In particular, they cannot be used to assess the effect of infection on growth, or for the interpretation of growth patterns and changes in growth velocity. Further, because of the wide genetic variation in height and weight between children of the same age, it is not possible to make inferences about growth trends from a single measurement. For example, a child whose cross-sectional Wt/A is 1 SD below the reference median could be a genetically small child whose weight is appropriate for its height, a child who is currently gaining weight rapidly after a past episode of slow weight gain, or an unhealthy child who is currently losing weight.

Beaton et al. (1990: 17) recommended two applications for one-time screening at the individual level, and one at the population level. In emergency situations, such as famines, individual one-time screening can be used to identify individuals requiring immediate attention in order to survive. In such circumstances wasting is more predictive of risk than stature, and Beaton et al. (1990: 19) recommended the use of weight-for-length (Wt/Ht) to identify candidates for food supplementation. They added that, although Wt/A also estimates wasting moderately well, in famine situations it may be difficult to determine age.

In non-emergency situations, individual one-time screening is commonly used to identify children in need of immediate nutrition and/or health intervention. For those under two years of age Beaton et al. (1990: 22) recommended the use of weight-for-length (Wt/Ht), and also length-for-age (Ht/A), since children under age two may still be young enough to achieve significant catch-up in height if their nutrition improves. For older children Wt/Ht is sufficient to identify candidates for intervention programmes.

If the objective of a one-time, non-emergency screening is to identify children in high-risk households, Beaton et al. (1990: 23) recommend the use of length-for-age (Ht/A) since stunting indicates long-term rather than short-term effects and is therefore more likely to reflect household patterns.

At the population level, one-time screening can be used to plan long-term health and nutrition interventions. In this case, growth failure is regarded as a proxy for inadequate diet, infectious disease and detrimental socio-environmental factors (Beaton et al., 1990: 18). The appropriate indicators for this type of assessment are length-for-age (Ht/A) or Wt/A.

5.2.3 Anthropometry, infection and mortality

There is a complex interaction between growth and infection. Martorell (1980: 81-82) characterized the association of diet and infection as 'the mechanism through which poverty retards growth and development of survivors'. Tomkins and Watson (1989) reviewed more than two hundred studies of the association of nutrition and infection, many of which demonstrate that infection promotes malnutrition and poor growth attainment by depressing appetites, depleting reserves of nutrients, altering metabolisms and causing malabsorption of nutrients. Malaria, diarrhoeal diseases, respiratory diseases, measles and pertussis, are especially likely to contribute to growth retardation. Children with these conditions have an inadequate dietary intake, which in turn leads to weight loss, growth faltering and reduced immunity to infection. However, Walker et al. (1992) noted that, while diarrhoea tended to have a long-term effect on growth, some other types of infection, such as fever, did not.

Nutrition impacts directly on child survival and growth attainment by affecting levels of morbidity. There is good evidence to indicate that immunocompetence is seriously impaired in severely malnourished children (Martorell and Ho, 1984: 63-64). In extreme cases this may result in immunological paralysis (Mata, 1985: 183). This greatly increases the risk of mortality. Rowland and Rowland (1985: 116) considered that boys tend to suffer more severely than girls, and bottlefed children more than breastfed children. They also pointed out that recurrent diarrhoea and growth faltering is essentially a disease of early childhood, with peak rates occurring in the second year of life. The lowest values in Wt/A also tend to occur at this time.

There is a circular and synergistic relationship between nutrition and infection, especially diarrhoea, as one aggravates the other. This may eventually lead to severe malnutrition and death. Foege (1984: 87) commented that 'the cycle of vaccine preventable diseases and malnutrition is potentiated by the debilitation and weight loss of diarrhoea'. Although full breastfeeding offers some protection against diarrhoea (Hirschhorn, 1987: 41), when breastmilk is no longer sufficient, the child is at risk of consuming contaminated food. This may precipitate diarrhoea attacks which lead to growth faltering, which in turn increases susceptibility to severe attacks.

Dodge (1983: 6) referred to the 'weanling's dilemma' which arises when breastmilk alone is no longer sufficient to sustain optimum growth, while ingestion of supplementary food carries the risk of infection and the commencement of a cycle of gastro-enteritis and malnutrition. This pattern has become so frequent and nutritionally significant in developing countries that it has become known as 'weanling diarrhoea' (Scrimshaw et al., 1983: 273). Mata's (1978) prospective study of 45 Guatemalan children showed that infants aged 0-5 months were sick from diarrhoea on average 6 per cent of the time, but this increased to 15 per cent for those aged 12-17 months and 18 per cent for children aged 18-23 months.

Episodes of infection are typically associated with declines in weight, which manifest clearly on growth charts (see, for example, growth charts in Werner, 1979: 304; and Gabr, 1985: 72). Gopolan and Chatterjee (1985: 9) commented that the diagnostic value of the widely used growth monitoring chart (health card) lies in its presentation of the relationship of growth to illness.

Specific diseases not only cause various nutritional problems, but may themselves be exacerbated by them, or may precipitate complex interactions. For example, measles interacts with protein-energy malnutrition (PEM) and Vitamin A deficiency to cause growth faltering and immune suppression (Tomkins and Watson, 1989: 5). Respiratory tract infection and chronic ear infections are more likely to occur in children suffering from Vitamin A deficiency (Tomkins and Watson, 1989: 5). The interaction between iron and infection is complex, and still the subject of debate. While iron deficiencies depress immune responses and so increase susceptibility to infections such as malaria, the iron deficiency itself may constrain the multiplication of pathogens, which cannot flourish without iron (Keusch and Farthing, 1986: 133; Tomkins and Watson, 1989: 7).

Poor growth is associated with weakness, reduced energy reserves and reduced ability to resist infection. Graitcer et al. (1981) found that children with a Wt/Ht more than 2 SDs below the reference median had nearly double the symptoms of those between plus and minus 1 SD. The higher infection rate for malnourished children may be attributed to differences in the quality of the environment between rich and poor. Moreover, the synergy between malnutrition and infection predisposes poorly nourished children to experience more severe and prolonged episodes of infection, compared with well nourished children. Martorell and Ho (1984: 64) concluded that the evidence for a higher frequency of infection was stronger for severely malnourished children than for mildly and moderately malnourished children, but poor nutritional status predisposed both groups to more severe attacks than were experienced by well-nourished children. Tomkins (1988: 188) considered that infection rates among children are higher in countries where malnutrition is prevalent, regardless of whether it is defined as stunting, wasting or underweight, but, within a single community, longitudinal studies tend not to show a clear association between stunting and incidence of infection.

Many studies have shown that certain levels of growth attainment are associated with high mortality (for example Mata, 1978; Martorell and Ho, 1984; Bhuiya, 1989). Alam, Wojtyniak and Rahaman (1989: 885) analysed data from the Teknaf Demographic Surveillance System and found that the mean nutritional status of children who subsequently died, as measured by six different anthropometric indices, was significantly lower than that of children who survived. Heywood (1982) measured a sample of Papua New Guinea children and returned two years later to record deaths. He found a strong negative correlation between mortality risk and Wt/A, length-for-age (Ht/A) and weight-for-length (Wt/Ht).

However, the strength and pattern of association with mortality varies between indicators. In Heywood's study length-for-age exhibited a threshold pattern, with a sharp increase in mortality for children below 85 per cent of the reference value. Other indicators were associated with a more gradual increase in mortality risk. In the Narangwal community in India, Kielmann and Associates (1983: 204) found that children aged up to one year who were under 70 per cent of the reference value for Wt/A were ten times as likely to die as those who were more than 80 per cent of Wt/A. For children aged 12-35.9 months, the risk for those under 70 per cent compared with those over 80 per cent was more than six fold. Kielmann and McCord (1978) related risk of mortality in Narangwal to nutritional status two months previously, and found that, on average, mortality of young children doubled with each additional 10 per cent below 80 per cent Wt/A.

While the association of very low Wt/A with a high mortality risk is strong, the pattern is less clear for Ht/A and moderately low Wt/A. Van Lerberghe (1988: 245) pointed out that, although countries with high infant and child mortality invariably have high prevalences of stunted children, in other countries such as Sri Lanka, Costa Rica, Panama and the former Yugoslavia low juvenile mortality rates coexist with high prevalences of stunting. Gaminiratne (1991) also noted the paradox of low mortality and high undernutrition in Sri Lanka, and concluded that although mild and moderate undernutrition was common, it did not pose a serious threat to survival. Few children in the 1987 Sri Lankan DHS data set were severely undernourished. Even severe stunting, underweight and wasting do not invariably result in mortality, although they substantially increase the risk of dying. Van Lerberghe (1988: 251 cited a study in Kasango, Zaire, which found the Ht/A distribution of the group of children who died, but were measured on average 2.3 months before death, had a similar normal distribution to that of the group of survivors.

Because individuals have differing abilities to withstand deprivation, and differing susceptibility to disease, the anthropometric status of those who become sick or die is also variable. Studies such as those of Chen, Chowdhury and Huffman (1980) and Heywood (1982) report threshold points beyond which mortality risks increase rapidly. There is also, presumably, an extreme point on the Wt/Ht scale beyond which all individuals have died. Nonetheless, many individuals die well before they reach these levels, while others who have very poor growth attainment eventually catch up and survive. In other words, poor growth attainment points to an enhanced risk of mortality, but there is no particular point at which mortality occurs. This has led many researchers to focus on evaluating the sensitivity and specificity of the various anthropometric measures as predictors of mortality.

One example is Alam, Wojtyniak and Rahaman's 1989 comparison of five indicators, mentioned above. Similarly, in Sudan, Ross et al. (1990: 636) found that, although a MUAC of 13.0 cm identified the same proportion of malnourished children as 80 per cent of the reference value for Wt/Ht, the individuals identified by the two measures were not always the same. They recommended against direct comparison of data from surveys using Wt/Ht and those using MUAC. Bairagi et al. (1985) evaluated the sensitivity and specificity of the velocity of weight and height increases, in addition to Wt/A, Ht/A and Wt/Ht. They concluded that Wt/A and Ht/A were better than weight and height velocity as predictors of mortality at ages greater than one year, but weight velocity was a good indicator of short-term mortality. Briend and Bari (1989) found that Wt/A was more sensitive than change in weight, for all levels of specificity, and hence a more efficient indicator of mortality risk.

The foregoing discussion indicates that the synergy between nutrition and infection has important implications for one-off, cross-sectional anthropometry. Even though the present study includes both anthropometry and reports of recent infection, it is impossible to determine from the short reference period for infection, and the lack of specific detail, whether poor growth attainment is primarily due to poor nutrition, to infection or to their combined effect. Analysis of longitudinal data could shed more light on the respective contributions of nutrition and infection. However, as discussed in Chapter One, in the absence of detailed data on morbidity and nutrition, their effect will be considered only as a combined effect in this study.

5.2.4 Nutrition, ethnicity and growth potential

An important consideration in any comparative study of anthropometric status is the possibility of genetic variation in growth potential. Mora (1985: 270) comments:

> *A major limitation of anthropometry is the difficulty of ascertaining the extent to which apparent deviations in growth are only the result of genetic variation or whether they can be attributed to environmental action or to genetic/environmental interaction. Allowing for the effect of genetic factors is a critical problem in interpreting anthropometric indicators.*

It is widely recognised that there are marked variations in the stature of adults belonging to different ethnic groups, and also that variation normally occurs within populations of the same ethnicity. As a consequence of centuries of migratory movements, many African national populations are heterogeneous. Different tribal groups exhibit observable differences in adult stature and build. This is very obvious in Burundi where the tall, Nilo-Hamitic Tutsi, the stockier Hutu of Bantu origin, and the Pygmoid Twa contrast strikingly in physical type. In his seminal work on the ethnic groups of sub-Saharan Africa, Hiernaux (1974: 51) commented

> *...it would completely obscure reality to pool two or three of them in a single sample on the basis that a common designation Barundi - meaning the inhabitants of Burundi - covers all three castes.*

The average Tutsi male stature of 176 cm is almost 10 cms greater than that of the Hutu, while that of the Twa averages around 155 cms (Hiernaux, 1974: 60, 122). Hiernaux designated the Tutsi 'Elongated East Africans' because of their tendency towards elongated physical features and slim limbs. Even though they are generally better nourished than the Hutu, because of their superior economic and social status, they are much leaner and have lower weight and narrower trunks for equal height (Hiernaux, 1974: 69). Hiernaux (1974: 82) attributed this to genetic differences as a result of the Tutsi evolving in the arid areas of the Sahara, where a lean and narrow body cools more efficiently, whereas the Hutu evolved in the cooler, moister southern climates, where a stocky form is an advantage.

As well as contrasts between the three Burundais ethnicities, there are regional variations within groups, attributable to differences in nutrition and infection. Hutu living at high altitudes have a better diet and suffer less malaria. Adults average seven kilograms heavier than Hutus in lower altitude areas, and have wider skeletal frames, but they are not significantly taller (Hiernaux, 1974: 66).

Although genetic differences between adult populations are widely recognised, most contemporary writers now agree that ethnic differences do not affect the growth potential of children up to age five. In 1977 Waterlow et al. (1977: 490) citing the research of Habicht et al. (1974b) and Eveleth and Tanner (1976), commented that 'the question of whether all child populations throughout the world have the same genetic potential for growth in size is still unresolved'. However, Habicht et al. (1974) concluded from their study of well-nourished children from different ethnic backgrounds that, generally, nutrition has a much greater impact on growth attainment in the first few years of life than ethnicity. They considered that the effect of ethnicity was so small, compared to that of nutrition and environment, that it was reasonable to use height and weight standards drawn from well-nourished white populations to compare with samples of children from other populations.

Similarly, Eveleth and Tanner (1976) found greater differences within ethnic groups living in different environments, than between ethnic groups in the same environment. They compared the height and weight of African children and adults, as documented in more than 50 studies and concluded that children from wealthier backgrounds in Africa, and urban Afro-Americans generally grew taller and heavier than their counterparts in poor circumstances and in rural areas. Up to age seven there was much more variation in the height and weight of African children than that of European children (Eveleth and Tanner, 1976: Figures 62-65, pp. 84-87). Tallest and heaviest were well-off children from Ibadan and Afro-Americans in Washington DC, even though the latter group were classified as low income by American standards. Ibadan poor were among the shortest and lightest.

Falkner (1985: 125) observed that, although there are ethnic differences in adult stature and maturation rates, all children in the world appear to follow similar growth patterns. Nonetheless, he added that at all ages children vary widely in stature and Wt/Ht, and there are no data available to determine how much variation would exist between ethnic groups if all children lived under optimum conditions. Martorell (1985) compared mean heights of seven-year-old boys in various countries, with various ethnicities and of high and low socio-economic status. He found that the more privileged Asians were consistently shorter, and possibly required a different standard. However, while the differences between white and blacks of low socio-economic status were substantial, there was little difference between those of high socio-economic status.

Eveleth (1986: 225) listed the main environmental influences on growth as nutrition, disease, socio-economic status, urbanization, physical activity, psychological stress, season of year and climate. Most of these factors affect growth by affecting nutrition, either directly or indirectly. However, she pointed out that individuals and populations are not uniformly affected by environmental factors, because of varying genetic characteristics. In Zaire Gerein (1988: 232) found that wasting was more common among the Nilotic Wahema than the Bantu Wangiti, while the reverse was true of stunting. Nonetheless, she attributed this to environmental rather than to ethnic differences. The cattle-herding Wahema may have been exposed to more infection because of faecal contamination, but their richer diets, which include milk and butter, allow greater catch-up growth after episodes of illness.

Although African children of comparable socio-economic levels tend to have lower birthweights than European children, by one or two years of age their height is similar or greater, and they are more skeletally advanced and mature at comparable ages than are Europeans (Eveleth, 1986: 223). Ebrahim (1978b: 8) reported that the average African child is more advanced developmentally than European children up to age three years, and that African babies of a few weeks old are comparable with European babies two or three times their age.

However, major differences in growth velocities between individuals of different ethnicities tend not to become apparent until adolescence. Falkner (1985: 125), on the other hand, suggested that genetic differences may become established only at puberty. Eveleth and Tanner (1976) found little difference in height between 16-year-old boys and girls in African tribal groups, while Afro-American boys had already experienced their adolescent growth spurt and were 9 to 10 cm taller than 16-year-old Afro-American girls. Growth spurts occur even later is some populations, with the mean for 18-year-old Tutsi boys still 12 cm below the adult mean, but that of Hutus almost the same as that of adults (Eveleth and Tanner, 1976: 88-89).

Pelletier (1991: 1077) commented that, even though the issue of ethnic differentials in the growth of young children largely has been settled in scientific circles, the use of reference values drawn from developed countries still presents difficulties when results are presented to policy audiences in developing countries. He attributed this controversy to three factors:

> *1) The mistaken assumption that commonly observed differences in average <u>adult</u> stature across populations reflect inter-population differences in genetic growth potential among adults <u>and</u> children; 2) The mistaken assumption that commonly observed familial tendencies for short or tall stature within a population (which often <u>do</u> have a genetic basis) implies the existence of similar genetic differences <u>between</u> populations; and 3) Related to the above, the feeling that the population in the country in question must be different in some way from all other populations in which the genetic hypothesis has been tested and rejected.* (Pelletier, 1991: 1077).

The foregoing discussion suggests that it is valid to compare the growth attainment of children under age five in the three study countries, even in the absence of specific data on ethnicity in Burundi and Zimbabwe. In Burundi it is likely that disparities in income, education and living standards, which tend to follow ethnic lines, are more likely to contribute to growth attainment differentials in Hutu and Tutsi children than is genetic variation.

5.3 ANTHROPOMETRY IN DHS DATA SETS

As stated in Chapter One, an important objective of the present study is to explore the patterns in the three data sets in order to assess the value of one-time cross-sectional measurements. Accordingly, the data are considered at face value in this analysis with no attempt to adjust for possible measurement errors. However, the potential for error is treated as an underlying limitation of such a data gathering exercise, and is continually referred to in the interpretation of statistics. Some potential sources of error are discussed here.

DHS-I attempted to collect the heights and weights of all children aged 3-36 months in Burundi, 0-60 months in Uganda and 3-60 months in Zimbabwe. Interviewers were trained to take accurate measurements using the procedures recommended by the United Nations manual *How to weigh and measure children* (BMI & IRD, 1988: 78; UMOH & IRD, 1989: 70; ZCSO & IRD, 1989: 10). Nonetheless, there was considerable scope for measurement error.

Children up to two years of age were placed in a supine position on a measuring board which measured their length. Older children had their height measured while they stood upright against a measuring stick. It is well known that it can be very difficult to measure the length of small children if they struggle and resist. Although measurers were instructed to press down on the child's knees to fully extend its legs, this may not have been done on all occasions, particularly when children were distressed. A measurement taken under difficult circumstances with a crying and struggling child and an anxious mother could easily differ from the true length of the child by several centimetres.

Similarly, there is potential for discrepancies in the height of older children, depending on how straight they stand, how much they stretch upwards and whether their feet are positioned correctly. Although measurers were trained to check these things, accuracy must be expected to vary between children and between measurers.

It is also difficult to obtain accurate weights. DHS-I used standardized 25-kg hanging scales, which are likely to be less accurate than modern digital scales, .

> *Trainees were taught to measure to DHS standards: these are to weigh children to within 100 gms of true weight...A test of weighing accuracy was carried out and each team was given two members who passed the test. During the survey spot checks on measurement techniques were made by an experienced anthropometrist and a second standardisation test was conducted to check on accuracy. (UMOH & IRD, 1989: 70).*

It will be noted that the stated objective was to weigh to within 100 gms, and weights were recorded in the data set only to the nearest 100 gms. However, the nature of spring scales is such that there is a tendency for the pointer to shift from zero after a weighing. Despite the checks mentioned above, it cannot be assumed that the scales were always centred. In Uganda and Zimbabwe the writer saw experienced nurses weigh infants in hanging scales with the pointer located up to +200 gms and -150 gms from zero at the commencement of weighing. Moreover, when children fidget or struggle, the pointer may oscillate and become difficult to read accurately (see Plate Four).

Although differences of one or two centimetres from true height, and a few hundred grams from true weight, need not be important in the case of an individual who is subject to regular monitoring, they could have a significant effect on the statistical analysis of these data sets. First, the degree of inaccuracy is likely to be skewed so as to be proportionally greater for younger children. This is because younger children are more likely to struggle and so contribute to an inaccurate reading. Moreover, a measurement error of 100-200 grams represents a greater proportion of the overall

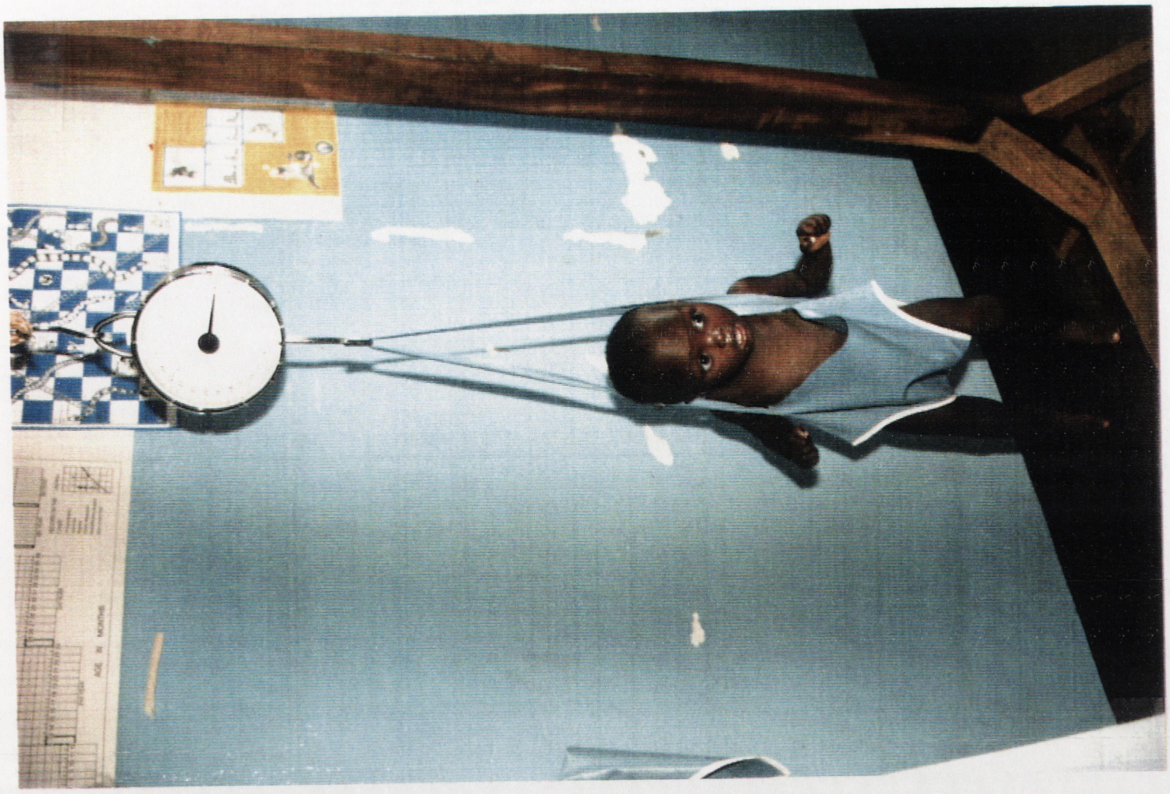


PLATE FOUR: Weighing a child, Mulago Hospital, Kampala weight of a small child, so is relatively more important than an error of this magnitude in the weight of a larger child. Second, inaccuracies are likely to be more common among particular measurers. Despite DHS claims that careful monitoring took place, it is to be expected that all measurers took more care than usual when a supervisor was nearby, and some would have taken less care when not supervised. There is no way of ascertaining the direction, distribution or extent of such errors.

As discussed in Chapter Three, DHS-I anthropometric data also are affected by sampling bias due to age displacement. Interviewers were instructed to measure all eligible children in order to avoid introducing sampling bias. However, Arnold (1991b) found evidence that interviewers had displaced children's ages in order to reduce their workload, by rendering them ineligible for the additional questions for young children. That is, some children aged up to 60 months were reported as over 60 months. The extent of age displacement was substantial in Burundi and moderate in Uganda and Zimbabwe, thus reducing the number of eligible children. Nonetheless, this is unlikely to affect the height and weight data of Burundi, where only children aged 3-36 months were measured.

Tables 5.1, 5.2 and 5.3 compare the distribution of the characteristics of measured children with those of children who were not measured, and indicates the actual number in each category. The age groups in this chapter, which are not the conventional demographic age groups, were selected to best accommodate the age range of measured children. It can be seen that in all three countries the proportions by birth, sex and maternal education were similar for both groups. There was slightly more difference between measured and unmeasured children in child's and mother's age distribution, and in the percentages from each region. The groups of children who were not measured tend to include higher percentages of young mothers, while the groups who were measured tend to have higher percentages of young children, presumably because younger children are more likely to be with their mothers, and hence accessible to field staff, than are older children.

Table 5.4 confirms this view. The most common reason given for not measuring children in Uganda and Zimbabwe was that they were absent from home at the time. Only a small proportion were not measured because they were sick. No information is available on the cause of the absence, but older children are more likely to be visiting another household on either a long- or short-term basis. It is unlikely that there was a consistent omission of children with any particular condition in these two countries.

Table 5.1: DISTRIBUTION OF CHARACTERISTICS OF MEASURED CHILDREN COMPARED WITH CHARACTERISTICS OF CHILDREN WHO WERE NOT MEASURED: BURUNDI (per cent)

	Measured %	Number	Not measured %	Number
Type of birth				
Single	98.8	(1971)	97.8	(104)
Multiple	1.2	(25)	2.2	(2)
Total	100.0	(1996)	100.0	(106)
Sex				
Male	51.0	(1018)	51.2	(55)
Female	49.0	(977)	48.8	(52)
Total	100.0	(1995)	100.0	(107)
Child's age (months)				
0-5	11.6	(231)	20.5	(22)
6-11	21.8	(434)	8.7	(9)
12-17	16.5	(329)	9.7	(10)
18-23	15.4	(308)	9.3	(10)
24-29	19.2	(383)	14.9	(16)
30-36	15.5	(310)	36.9	(39)
Total	100.0	(1995)	100.0	(106)
Mother's age (years)				
15-19	0.8	(16)	1.6	(2)
20-24	18.2	(362)	25.3	(27)
25-29	31.1	(621)	44.0	(47)
30-34	24.5	(489)	14.9	(16)
35-39	16.2	(324)	9.9	(11)
40-44	6.3	(125)	4.3	(5)
45-49	2.9	(57)	0.0	(0)
Total	100.0	(1994)	100.0	(108)
Region				
Imbo	7.4	(147)	11.2	(12)
Mumirwa	12.3	(245)	7.5	(8)
Mugamba	9.2	(186)	14.1	(15)
Central Plateau	55.0	(1097)	54.3	(58)
Depressions	16.1	(321)	12.9	(14)
Total	100.0	(1996)	100.0	(107)
Residence				
Urban	3.0	(60)	6.3	(7)
Rural	97.0	(1935)	93.7	(100)
Total	100.0	(1995)	100.0	(107)
Mother's education				
None	80.8	(1612)	78.3	(83)
Primary	16.6	(332)	18.9	(20)
Secondary	2.3	(44)	2.4	(3)
Tertiary	0.3	(7)	0.4	(1)
Total	100.0	(1995)	100.0	(107)

SOURCE: As for Table 4.4.

Table 5.2: DISTRIBUTION OF CHARACTERISTICS OF MEASURED CHILDREN COMPARED WITH CHARACTERISTICS OF CHILDREN WHO WERE NOT MEASURED: UGANDA (per cent)

	Measured		Not measured	
	%	Number	%	Number
Type of birth				
Single	97.3	(3776)	96.1	(542)
Multiple	2.7	(102)	3.9	(22)
Total	100.0	(3878)	100.0	(564)
Sex				
Male	49.2	(1907)	48.1	(271)
Female	50.8	(1972)	51.9	(292)
Total	100.0	(3879)	100.0	(563)
Child's age (months)				
0-5	13.8	(535)	7.2	(41)
6-11	13.2	(511)	2.9	(17)
12-17	12.3	(479)	5.8	(33)
18-23	10.0	(388)	6.4	(36)
24-29	9.5	(367)	10.1	(57)
30-35	9.0	(350)	11.2	(63)
36-41	10.0	(389)	13.2	(75)
42-47	7.2	(279)	13.0	(73)
48-53	8.1	(315)	14.8	(83)
54-60	6.9	(266)	15.4	(87)
Total	100.0	(3879)	100.0	(565)
Mother's age (years)				
15-19	8.6	(334)	8.7	(49)
20-24	25.2	(978)	34.9	(197)
25-29	28.1	(1087)	28.8	(162)
30-34	18.1	(703)	13.1	(74)
35-39	12.8	(498)	9.5	(54)
40-44	5.5	(214)	4.5	(25)
45-49	1.7	(64)	0.5	(3)
Total	100.0	(3878)	100.0	(564)
Region				
West Nile	5.8	(225)	4.1	(23)
East	27.5	(1067)	27.3	(154)
Central	23.7	(921)	32.6	(183)
West	6.2	(240)	6.4	(36)
South West	32.0	(1239)	21.4	(120)
Kampala	4.8	(187)	8.2	(46)
Total	100.0	(3879)	100.0	(562)
Residence				
Urban	8.9	(345)	16.1	(91)
Rural	91.1	(3534)	83.9	(473)
Total	100.0	(3879)	100.0	(564)
Mother's education				
None	42.2	(1635)	35.3	(199)
Primary	50.0	(1941)	51.9	(292)
Secondary	7.6	(296)	12.5	(71)
Tertiary	0.2	(7)	0.3	(2)
Total	100.0	(3879)	100.0	(564)

SOURCE: As for Table 4.5.

Table 5.3: DISTRIBUTION OF CHARACTERISTICS OF MEASURED CHILDREN COMPARED WITH CHARACTERISTICS OF CHILDREN WHO WERE NOT MEASURED: ZIMBABWE (per cent)

	Measured %	Number	Not Measured %	Number
Type of birth				
Single	96.3	(2389)	97.4	(563)
Multiple	3.7	(90)	2.6	(15)
Total	100.0	(2479)	100.0	(578)
Sex				
Male	50.0	(1239)	48.4	(280)
Female	50.0	(1240)	51.6	(298)
Total	100.0		100.0	
Child's age (months)				
0-5	7.5	(187)	4.9	(28)
6-11	10.4	(257)	6.1	(35)
12-17	11.8	(291)	5.4	(31)
18-23	10.4	(259)	9.5	(55)
24-29	11.8	(291)	9.9	(57)
30-35	9.9	(246)	8.3	(48)
36-41	10.1	(251)	13.1	(76)
42-47	8.1	(202)	10.7	(62)
48-53	10.7	(265)	14.5	(84)
54-60	9.3	(230)	17.6	(102)
Total	100.0	(2479)	100.0	(578)
Mother's age (years)				
15-19	4.9	(122)	5.7	(33)
20-24	23.0	(570)	32.1	(186)
25-29	26.1	(647)	23.2	(134)
30-34	22.2	(550)	18.9	(109)
35-39	14.6	(363)	12.8	(74)
40-44	6.4	(158)	5.9	(34)
45-49	2.8	(69)	1.4	(8)
Total	100.0	(2479)	100.0	(578)
Region				
Manicaland	14.3	(354)	10.0	(58)
Mash. Central	7.4	(184)	7.3	(42)
Mash East	14.0	(348)	12.2	(70)
Mash West	12.0	(298)	11.9	(69)
Mat North	5.0	(123)	4.3	(25)
Mat South	7.4	(184)	6.2	(36)
Midlands	14.8	(366)	16.7	(96)
Masvingo	13.0	(322)	8.3	(48)
Harare/Chit.	5.8	(143)	11.2	(65)
Bulawayo	6.3	(157)	11.9	(69)
Total	100.0	(2479)	100.0	(578)
Residence				
Urban	23.4	(578)	40.5	(234)
Rural	76.6	(1901)	59.5	(344)
Total	100.0	(2479)	100.0	(578)
Mother's education				
None	18.8	(465)	16.4	(95)
Primary	64.6	(1602)	58.3	(337)
Secondary	16.2	(401)	24.4	(141)
Tertiary	0.4	(11)	0.9	(5)
Total	100.0	(2479)	100.0	(578)

SOURCE: As for Table 4.6.

Precise reasons for not measuring children are not available for Burundi. However, a higher proportion of target children were measured in that country. Only 5.1 per cent of the target group were not measured, with measurements unavailable for a further 3.2 per cent because of errors or missing ages. This compares with 12.8 per cent not measured in Uganda and 19.2 per cent not measured in Zimbabwe. Presumably this is because the age range of children in the three countries does not correspond exactly. As only younger children were eligible for measurement in Burundi, the incidence of absenteeism was lower than amongst the broader age groups in Uganda and Zimbabwe.

Table 5.4: REASONS FOR NOT MEASURING ELIGIBLE CHILDREN: BURUNDI, UGANDA AND ZIMBABWE

BURUNDI

Reasons for non-measurement not available

Per cent of all eligible children not measured **5.1 %**

UGANDA

	%	Number
Child sick	8.7	(49)
Child away	72.6	(414)
Parent refused	4.4	(25)
Scale damaged	0.3	(2)
Other unspecified	8.4	(48)
Not known	5.6	(32)
	100.0	(570)

Per cent of all eligible children not measured **12.8 %**

ZIMBABWE

	%	Number
Child sick	4.8	(28)
Child away	59.6	(350)
Mother refused	1.5	(9)
Child asleep	3.1	(18)
No measurers	0.2	(1)
Other unspecified	2.4	(14)
Not known	28.4	(167)
Total	100.0	(587)

Per cent of all eligible children not measured **19.2 %**

SOURCE: As for Tables 4.4, 4.5 and 4.6.

Since measurement errors are likely to become progressively greater as age decreases, it is arguable that the data for the Ugandan children under age three months are most likely to be unreliable. Accordingly they have been excluded from tables which compare the three countries. In comparative tables Ugandan and Zimbabwean children are generally treated as two age groups: 3-36 months to compare with Burundi, and 3-60 months to compare with each other.

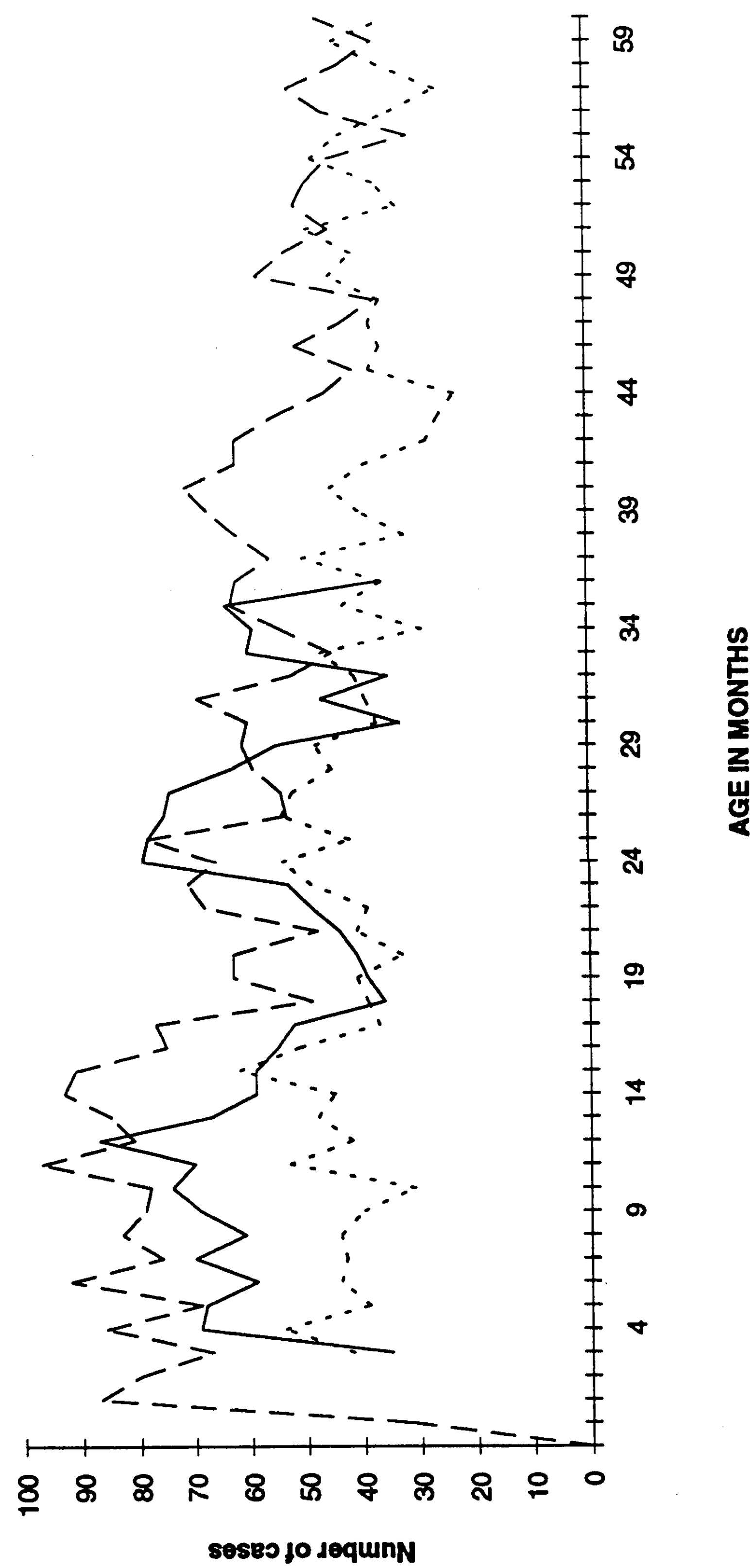
Figure 5.1 shows the age distribution of all measured singleton births by single months of age. It can be seen that there is considerable variation in the numbers of children of each age measured, ranging from 97 aged 11 months in Uganda to 23 aged 44 months in Zimbabwe. There appears to be some age heaping, particularly at age 24 months in Burundi.

Although this could be a random effect, another possible explanation is that five per cent of Burundais birth dates at age 24 months and almost eight per cent at 36 months were imputed by computer during data processing (Arnold, 1990, 86). On the other hand, Arnold reports that Ugandan data on birth dates were 99.9 per cent or more complete, including day of birth, so there is no obvious explanation for the variation in this country. It is possible that some birth dates were imputed in the field by interviewers or supervisors, but this is neither documented (Arnold, 1990: 84) nor believed to have occurred by those associated with the survey.

There were generally more Ugandan children measured at each age than Burundais or Zimbabwean children, especially at ages up to 18 months. There were also more Burundais children aged up to 14 months measured than Zimbabwean children in that age group. This can be partially explained by higher fertility in Burundi and Uganda than in Zimbabwe. The small number of Ugandan children aged less than one month must be attributed to a reluctance of mothers to allow field teams to handle new-borns. The relatively lower numbers measured in older age groups in Uganda are probably because of generally higher mobility of older children, plus greater social disruption in this country.

Figure 5.2 depicts the measured singleton age distribution, smoothed into six-month age groups. It can be seen that the variation between countries and between age groups persists. The largest group is 513 Ugandan children aged 0-6 months, and the smallest 179 Zimbabwe children aged 3-6 months. Zimbabwe tends to have the most consistent sample size across all age groups. Despite variations, the sample size at each age is

FIGURE 5.1: AGE DISTRIBUTION OF ALL MEASURED CHILDREN; BURUNDI, UGANDA AND ZIMBABWE



Source: As for Tables 4.4, 4.5 and 4.6.

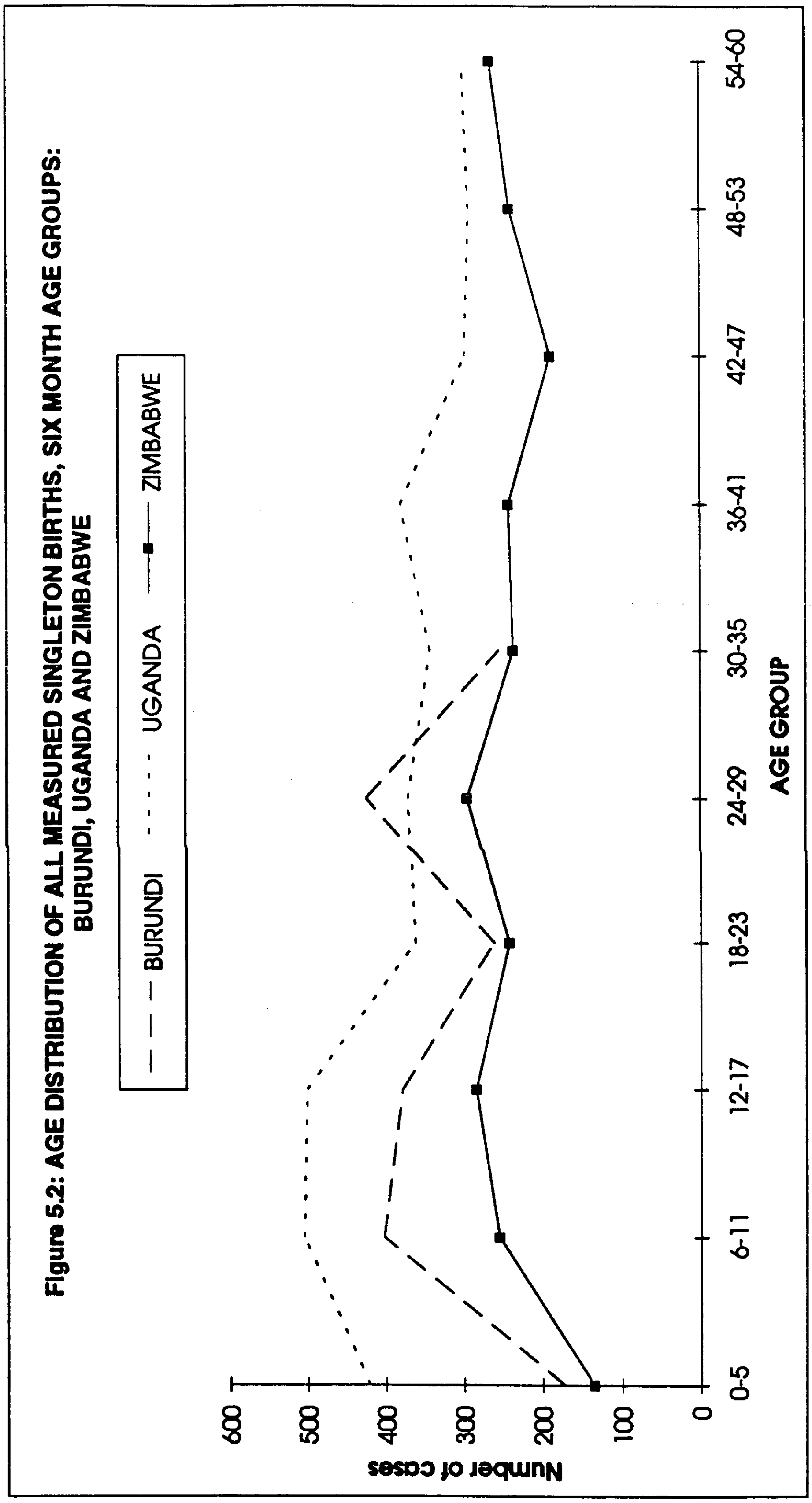


Figure 5.2: AGE DISTRIBUTION OF ALL MEASURED SINGLETON BIRTHS, SIX MONTH AGE GROUPS: BURUNDI, UGANDA AND ZIMBABWE

Source: As for Tables 4.4, 4.5 and 4.6.

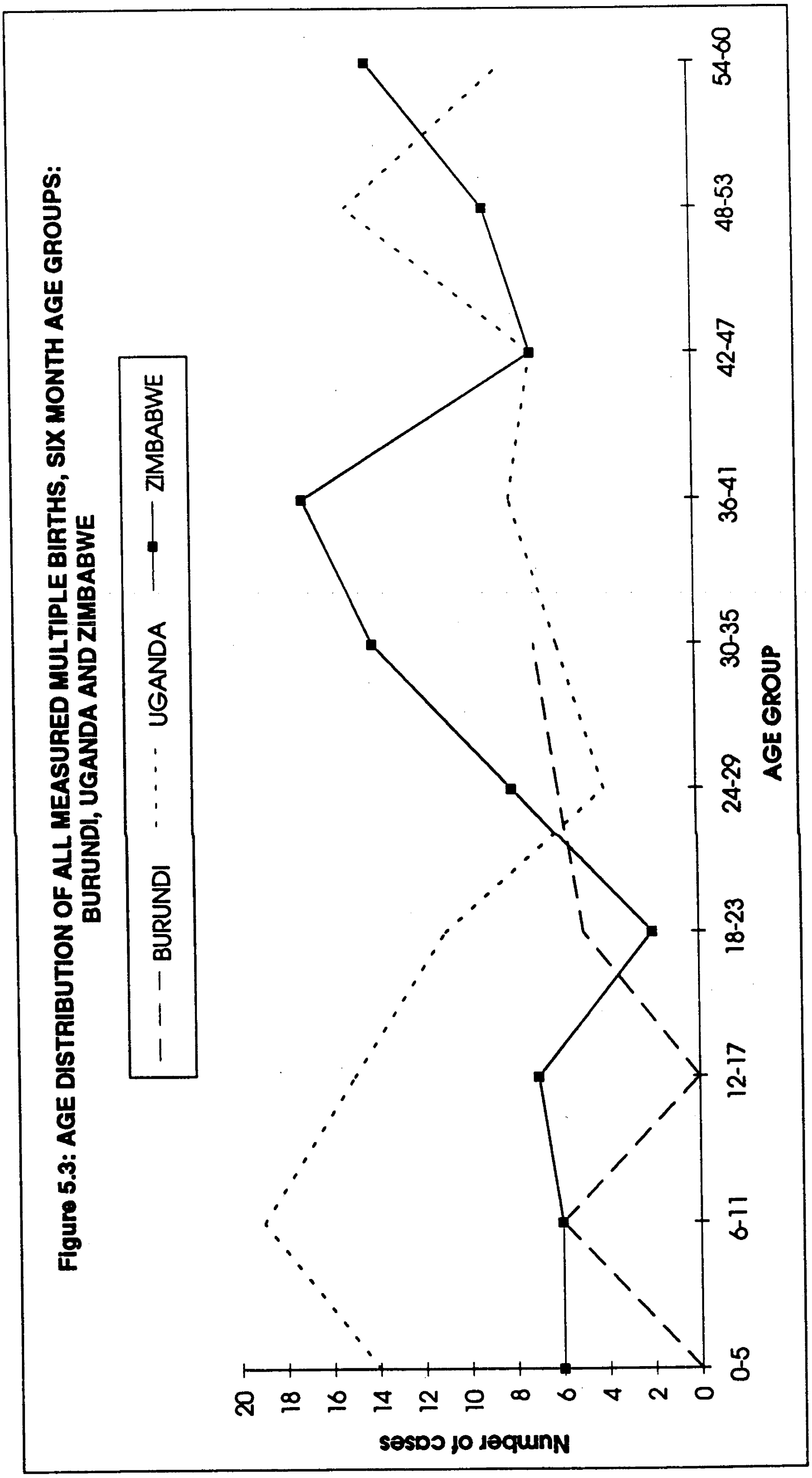


Figure 5.3: AGE DISTRIBUTION OF ALL MEASURED MULTIPLE BIRTHS, SIX MONTH AGE GROUPS: BURUNDI, UGANDA AND ZIMBABWE

Source: As for Tables 4.4, 4.5 and 4.6.

substantial compared with many anthropometric studies, and there are sufficient cases to support statistically significant conclusions.

Figure 5.3 shows the age distribution of multiple births by six-month age groups. This distribution is more uneven because of the relatively small number of multiple births overall. Guang and Grummer-Strawn (1993: 502) commented that it is standard practice to analyse mortality of twins separately, because they have different patterns from singleton births. Similarly, multiple births appear to have different patterns of growth attainment, with a high propensity for being small and physically disadvantaged. Accordingly, multiple births are treated separately in the following analysis. In most cases it is not possible to draw significant statistical conclusions about them, because of small numbers and uneven distributions.

5.3.1 Raw heights and weights

In order to demonstrate the effect of standardization on growth data, this analysis begins with an exploration of the pattern of raw heights and weights according to age. Figure 5.4 plots the distributions of raw heights of all measured singletons, male and female singletons and all multiple births in the three countries. Figure 5.4 compares only children aged up to 36 months in the three countries, and Annex Figure 1 compares the wider age groups for Uganda and Zimbabwe only. The graphs of raw height for Burundais and Ugandan children aged 36 months and under are distinguished by a slight 'twin peak' pattern for singleton births, as a result of a small deficit of children in the 70-75 cm height range. This contrasts with the smooth curve for Zimbabwe. All measured Ugandan children, including those aged 0-2 months, were included, which is reflected in the longer left-hand tail to the Uganda plots. The plot for Zimbabwe males aged 3-36 months is closest to a normal curve.

The plots for children aged up to 60 months for both Uganda and Zimbabwe (Annex Figure 1) are more uneven than those for younger children only. Some of the irregularities in these graphs can be attributed to variations in sample size at each age, but they also reflect the increasing variability of older children. This points to the need for an age-standardized indicator.

Raw weights for children aged up to 36 months are plotted in Figure 5.5. Annex Figure 2 shows raw weights for all measured children in Uganda and Zimbabwe. The curves for raw weight are generally more evenly distributed than those for raw height, although those for Ugandan and Zimbabwean children aged up to 36 months have sharp

Figure 5.4A: DISTRIBUTION OF RAW HEIGHTS OF MEASURED CHILDREN AGED 3 - 36 MONTHS: BURUNDI

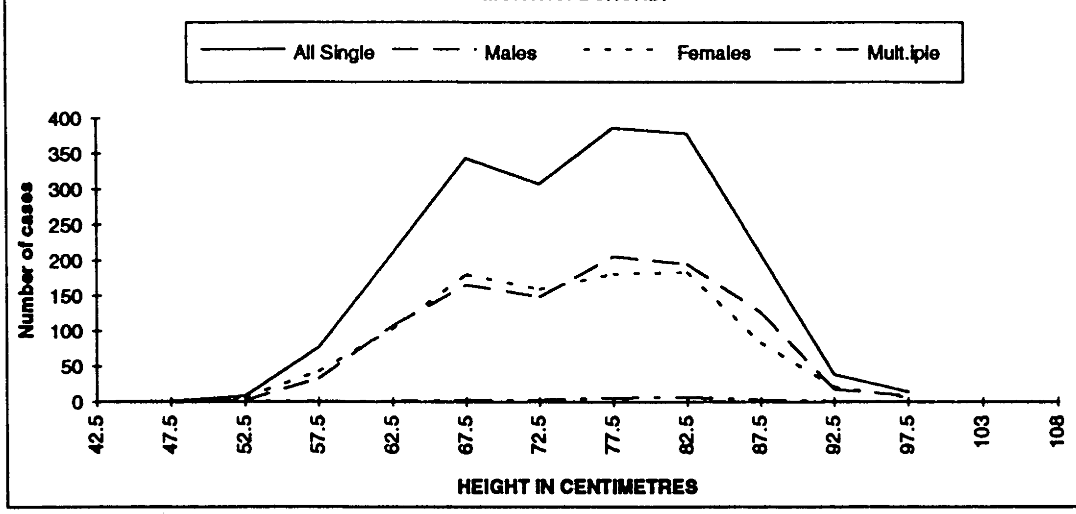


Figure 5.4B: DISTRIBUTION OF RAW HEIGHT OF MEASURED CHILDREN AGED 0 - 36 MONTHS: UGANDA

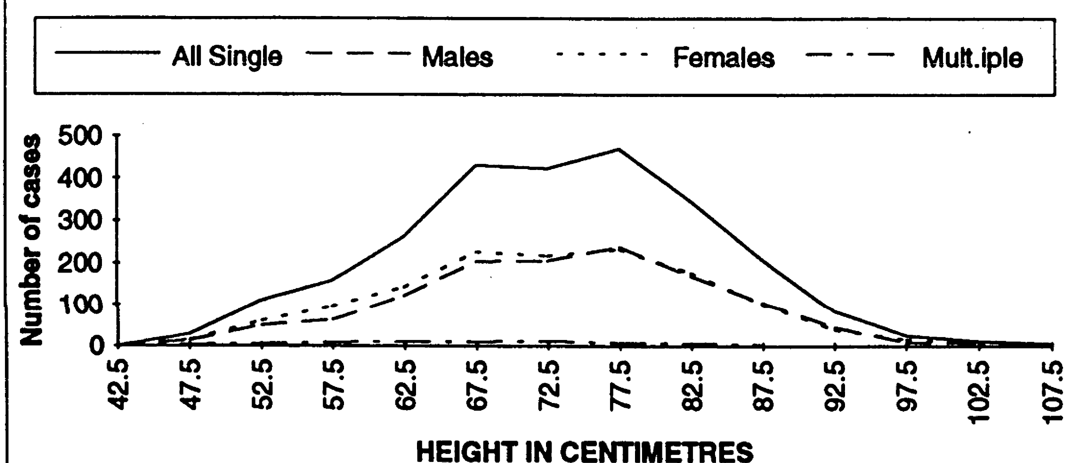
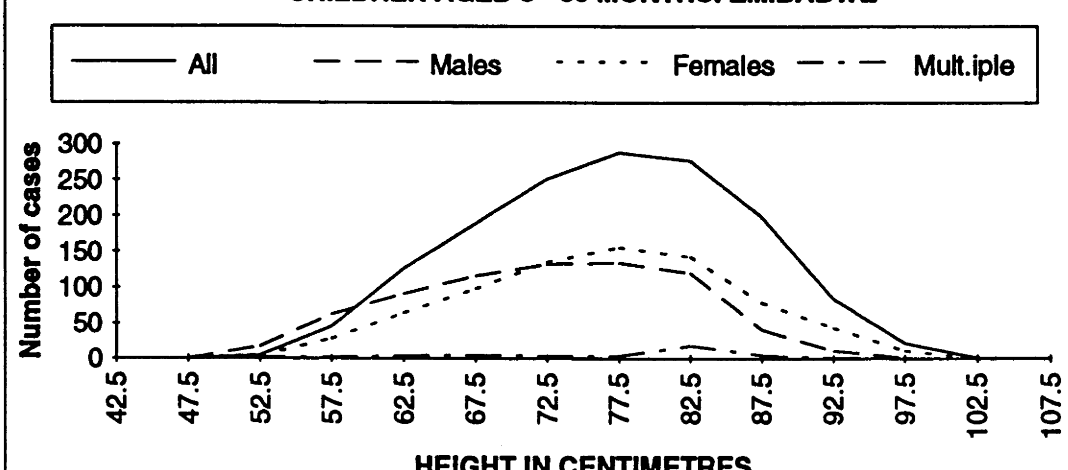


Figure 5.4C: DISTRIBUTION OF RAW HEIGHTS OF MEASURED CHILDREN AGED 3 - 36 MONTHS: ZIMBABWE



Source: As for Tables 4.4, 4.5 and 4.6.

Figure 5.5A: DISTRIBUTION OF RAW WEIGHTS OF MEASURED CHILDREN AGED 3 - 36 MONTHS: BURUNDI

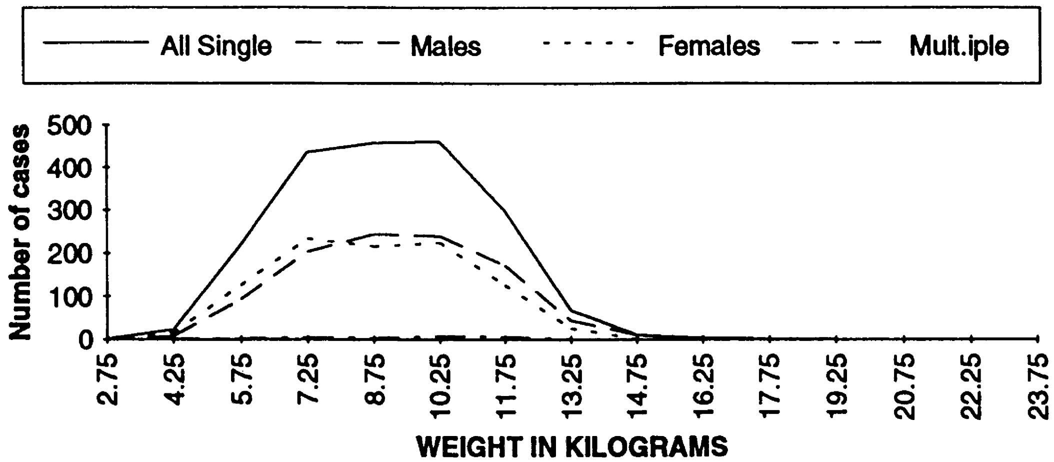


Figure 5.5B: DISTRIBUTION OF RAW WEIGHTS OF MEASURED CHILDREN AGED 0 - 36 MONTHS: UGANDA

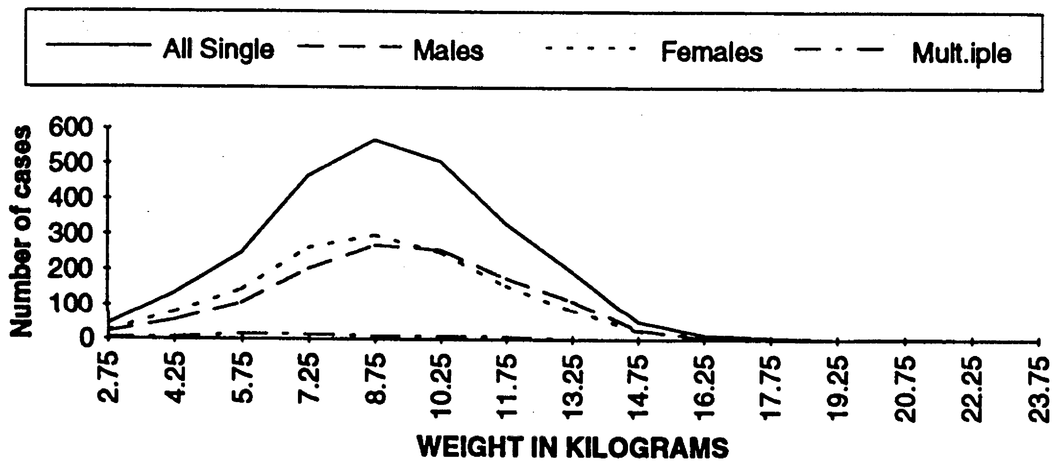
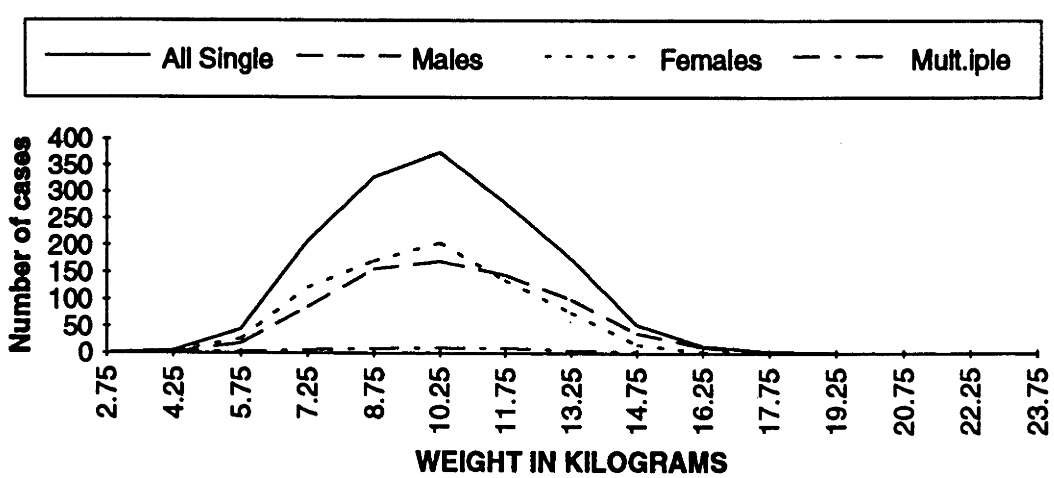


Figure 5.5C: DISTRIBUTION OF RAW WEIGHTS OF MEASURED CHILDREN AGED 3 - 36 MONTHS: ZIMBABWE



Source: As for Tables 4.4, 4.5 and 4.6,

peaks. It is difficult to draw any conclusions from these raw heights and weights. The irregularities could be due to social or environmental effects, and also to variations in the size of the sample at each age. In all plots the curves for males tend to be displaced slightly to the right compared with those for females, indicating a tendency for male children to be taller and heavier.

Table 5.5 shows the mean, median and standard deviation of the raw height for the three populations. In these tables Ugandan children under age 3 months were excluded to increase comparability. It can be seen that Zimbabwe has consistently higher mean values for all groups, but the margin is not great. Similarly, the medians and standard deviations are slightly higher for Zimbabwe than for comparable age groups in the two other countries. This could be partly an effect of the smaller proportions in the youngest age groups in Zimbabwe than in Uganda and Burundi, but could also reflect better living conditions in Zimbabwe. Within countries, similar patterns pertain. As would be expected from inspection of Figures 5.4 and 5.5, the mean and median values for girls are consistently lower than those for boys.

The reference values for multiple births are erratic. In Zimbabwe they are similar to those for singletons, but in Burundi they are higher, and in Uganda lower. Little importance should be attached to these differences, because of the small number of cases in this category.

The distribution of raw weights in Table 5.6 echoes the patterns in Table 5.5. Again Zimbabwe has the highest means for both ages 3-36 months and 3-60 months, with the one kilogram difference between Uganda and Zimbabwe in the second age group almost certainly reflecting better living conditions in Zimbabwe. Females are slightly below males in all three countries, and again the values for multiple births are erratic.

5.3.2 Height, weight and age

The most obvious relationship in growth attainment of young children is that between height, weight and age. As discussed above, children grow at different rates throughout childhood, and these rates are roughly associated with specific age ranges, although there is individual variation, and growth often occurs in spurts. Figure 5.6 shows the 'Road to Health' weight chart developed by Morely (Morely and Woodland, 1979) and now a part of the health card commonly used throughout the world. Although the chart allows for a range of weights, the general pattern is that weight velocity is most rapid for infants in the first few months of life, then gradually levels off.

Table 5.5: DISTRIBUTION OF RAW HEIGHT OF MEASURED CHILDREN: BURUNDI, UGANDA AND ZIMBABWE (centimetres)

	Mean	Std. Dev.	Median	n
BURUNDI (3-36 months)				
Singletons				
Males	75.6	8.9	76.1	996
Females	74.4	9.0	74.7	940
All	75.0	9.0	75.4	1936
Mulitple Births	76.6	9.7	77.7	26
UGANDA (3-36 months)				
Singletons				
Males	75.1	9.0	75.0	1132
Females	74.2	9.6	74.0	1230
All	74.7	9.3	74.4	2362
Multiple Births	69.2	9.3	69.4	61
ZIMBABWE (3-36 months)				
Singletons				
Males	77.3	9.4	77.5	726
Females	76.2	9.2	76.5	760
All	76.7	9.3	11.1	1486
Multiple Births	76.3	10.6	81.5	45
UGANDA (3-60 months)				
Singletons				
Males	82.0	12.5	82.0	1760
Females	80.6	12.9	79.9	1814
All	81.3	12.7	80.8	3573
Multiple Births	77.3	13.8	77.5	98
ZIMBABWE (3-60 months)				
Singletons				
Males	85.3	13.1	86.2	1197
Females	83.9	13.3	83.4	1192
All children	84.6	13.2	84.5	2389
Multiple Births	85.3	12.5	87.1	90

SOURCE: As for Tables 4.4, 4.5 and 4.6.

Table 5.6: DISTRIBUTION OF RAW WEIGHT OF MEASURED CHILDREN: BURUNDI, UGANDA AND ZIMBABWE (kilograms)

	Mean	Std Dev	Median	n
BURUNDI (3-36 months)				
Singletons				
Males	9.3	2.2	9.3	999
Females	8.8	2.1	8.7	941
All	9.3	2.3	9.5	26
Multiple births	9.1	2.1	9.0	1940
UGANDA (3-36 months)				
Singletons				
Males	9.6	2.4	9.5	1133
Females	9.2	2.4	9.0	1232
All	9.4	2.4	9.2	2365
Multiple births	7.9	2.3	7.5	61
ZIMBABWE (3-36 months)				
Singletons				
Males	10.4	2.3	10.4	725
Females	9.9	2.2	9.9	759
All	10.1	2.3	10.1	1484
Multiple births	9.8	2.6	10.2	45
UGANDA (3-60 months)				
Singletons				
Males	11.3	3.2	11.2	1760
Females	10.7	3.3	10.5	1814
All	11.0	3.3	10.8	3574
Multiple births	9.8	3.4	9.8	98
ZIMBABWE (3-60 months)				
Singletons				
Males	12.3	3.2	12.3	1196
Females	11.6	3.2	11.4	1189
All children	12.0	3.2	11.9	2385
Multiple births	12.0	3.2	12.1	90

SOURCE: As for Tables 4.4, 4.5 and 4.6.

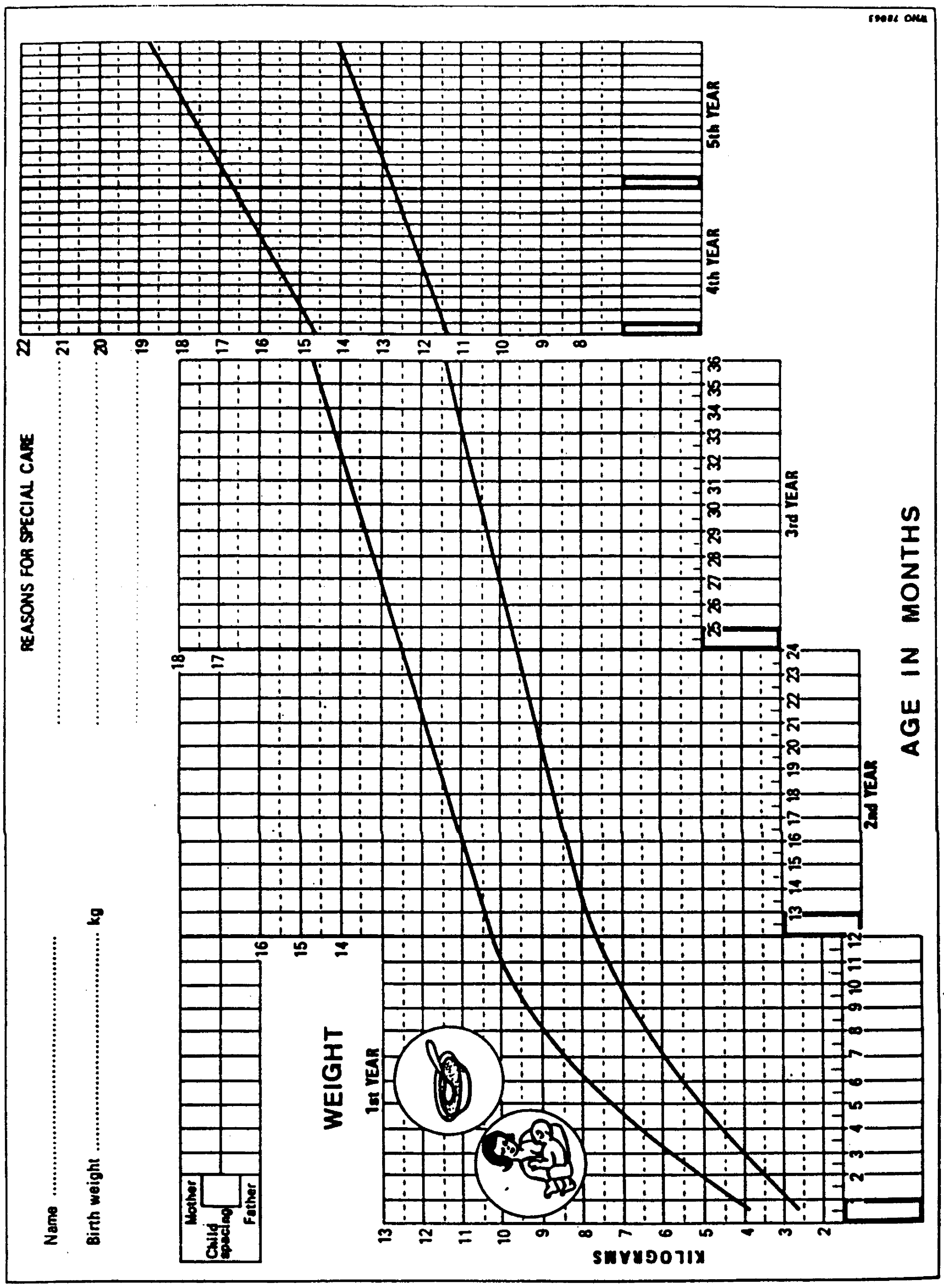


Figure 5.6: THE 'ROAD TO HEALTH' WEIGHT MONITORING CHART

Tables 5.5 and 5.6, Figures 5.4 and 5.5, and Annex Figures 1 and 2 make no adjustment for age differences in the samples. In order to test how much of the variation in growth attainment can be attributed to age alone, the raw heights and weights for the three countries were regressed against age. This analysis was performed separately for each sex, and for singleton and multiple births. Ugandan children under age three months were excluded to improve comparability of the samples.

As expected, Tables 5.7 and 5.8 show a highly significant relationship between age and height, and age and weight, in each country. The adjusted r^2 values in Table 5.7 show that, for every group, the proportion of variation in height explained by age was more than 50 per cent, and, except for multiple births in Burundi, 70 per cent or more. The difference between the r^2 values and 1.0 is the proportion of variation due to factors other than age.

The highest r^2 values for children aged 3-36 months are for Zimbabwe, and the lowest for Uganda. Political instability and regional differences could reduce the strength of the relationship with age in both Burundi and Uganda. The higher r^2 in Zimbabwe is consistent with uniformly better economic conditions than in Burundi and Uganda.

The r^2 for Ugandans aged 3-60 months is 10 percentage points higher than for children aged 3-36 months, but still less than that for Zimbabwean children of the same age. The higher values for Zimbabwe in the broader age range again suggest the effect of better economic conditions.

Except in the case of Zimbabwean children aged 3-36 months, there is little variation in the pattern by sex. The value for Burundais females is slightly higher than that for males, with the reverse true of Zimbabwe. The pattern for multiple births is inconsistent in all three countries, with age sometimes explaining more and sometimes less of the variation in height than for singleton births. Although statistically significant, it cannot be regarded as important because of small numbers of cases.

Table 5.8 indicates that age generally explains less of the variation in weight than in height. There is little difference between countries in the adjusted r^2 values for all singleton children aged 3-36 months, with age explaining only about 60 per cent of the variation. Age explains more of the variation for Burundais females aged 3-36 months and Zimbabwean and Ugandan females aged 3-60 months than for males in the same age groups, with the coefficients for age indicating a steeper slope. This suggests that females tend to be disadvantaged early in life, but catch up more quickly.

Table 5.7: REGRESSION OF RAW HEIGHT WITH AGE: BURUNDI, UGANDA AND ZIMBABWE

	Constant (cm)	b1.AGE (cm)	Adj r2	S.E. (cm)	Signif. F	Number
BURUNDI (3-36 months)						
Singletons						
Males	60.75	0.77	0.72	4.67	p=<0.001	(1007)
Females	59.60	0.78	0.73	4.59	p=<0.001	(964)
All	60.18	0.78	0.72	4.66	p=<0.001	(1971)
Multiple births	58.41	0.80	0.53	6.79	p=<0.001	(24)
UGANDA (3-36 months)						
Singletons						
Males	60.91	0.79	0.70	4.94	p=<0.001	(1132)
Females	59.27	0.82	0.70	5.25	p=<0.001	(1230)
All	60.06	0.80	0.70	5.13	p=<0.001	(2362)
Multiple births	55.53	0.96	0.77	4.45	p=<0.001	(61)
ZIMBABWE (3-36 months)						
Singletons						
Males	60.76	0.85	0.81	4.12	p=<0.001	(726)
Females	60.04	0.85	0.75	4.59	p=<0.001	(760)
All	60.38	0.85	0.78	4.38	p=<0.001	(1484)
Multiple births	57.55	0.88	0.87	3.87	p=<0.001	(45)
UGANDA (3-60 months)						
Singltons						
Males	62.75	0.67	0.80	5.52	p=<0.001	(1760)
Females	61.12	0.70	0.80	5.85	p=<0.001	(1814)
All	61.90	0.69	0.80	5.71	p=<0.001	(3573)
Multiple births	59.72	0.65	0.74	7.01	p=<0.001	(98)
ZIMBABWE (3-60 months)						
Singletons						
Males	62.72	0.73	0.86	4.86	p=<0.001	(1197)
Females	61.78	0.74	0.87	4.88	p=<0.001	(1192)
All	62.23	0.74	0.86	4.88	p=<0.001	(2389)
Multiple births	60.57	0.72	0.87	4.54	p=<0.001	(90)

SOURCE: As for Tables 4.4, 4.5 and 4.6.

Table 5.8: REGRESSION OF RAW WEIGHT WITH AGE: BURUNDI, UGANDA AND ZIMBABWE

	Constant (kg)	b1.AGE (kg)	Adj r2	S.E. (kg)	Signif. F	Number
BURUNDI (3-36 months)						
Singltons						
Males	6.05	0.17	0.59	1.36	p=<0.001	(1010)
Females	5.54	0.17	0.65	1.23	p=<0.001	(965)
All	5.80	0.17	0.61	1.31	p=<0.001	(1975)
Multiple Births	4.10	0.22	0.65	1.46	p=<0.001	(24)
UGANDA (3-36 months)						
Singletons						
Males	6.10	0.20	0.63	1.45	p=<0.001	(1133)
Females	5.70	0.19	0.58	1.57	p=<0.001	(1232)
All	5.89	0.19	0.60	1.53	p=<0.001	(2365)
Multiple Births	4.78	0.22	0.66	1.36	p=<0.001	(61)
ZIMBABWE (3-36 months)						
Singletons						
Males	6.84	0.19	0.64	1.37	p=<0.001	(725)
Females	6.37	0.18	0.61	1.37	p=<0.001	(759)
All	6.59	0.18	0.62	1.39	p=<0.001	(1484)
Multiple Births	5.79	0.19	0.67	1.50	p=<0.001	(45)
UGANDA (3-60 months)						
Singletons						
Males	6.60	0.16	0.71	1.74	p=<0.001	(1760)
Females	6.03	0.17	0.72	1.74	p=<0.001	(1814)
All	6.30	0.17	0.71	1.75	p=<0.001	(3574)
Multiple Births	5.77	0.15	0.64	2.03	p=<0.001	(98)
ZIMBABWE (3-60 months)						
Singletons						
Males	7.17	0.17	0.74	1.64	p=<0.001	(1196)
Females	6.62	0.17	0.76	1.58	p=<0.001	(1189)
All children	6.88	0.17	0.75	1.63	p=<0.001	(2385)
Multiple Births	6.05	0.17	0.77	1.50	p=<0.001	(90)

SOURCE: As for Tables 4.4, 4.5 and 4.6.

An interesting feature of Tables 5.7 and 5.8 is that the non-linear nature of early growth patterns results in constant values that are much higher than normal heights and weights at birth. Moreover, the slope is steeper and the cut-off lower for Ugandan and Zimbabwean children aged 3-36 months than for the wider age groups for these countries. This slowing in velocity of weight gain as children grow older reflects the normal curves in the 'Road to Health' chart, depicted in Figure 5.6. Data for children in the first few weeks of life would thus be expected to show steeper slopes, and cut-off points approximating normal birth heights and weights.

5.3.3 Standardized measures

The utility of raw heights and weights is limited to describing group patterns, and the size of one individual in relation to another in absolute terms. Although they are sufficient when all children in a sample are the same age, or when a sample comprises adult populations who have stopped growing, they do not support detailed analysis of children of differing ages.

In Figures 5.4 and 5.5 and Annex Figures 1 and 2, it is not possible to distinguish the effects of age from other factors. The regressions of age with raw height and weight indicate that age explains a substantial part, but not all, of the variation in the three data sets. To evaluate the contribution of other factors it is essential to use age standardized measures.

The DHS data sets include Ht/A, Wt/A and Wt/Ht in three different forms as computed variables to two decimal places:

(1) as proportions in each centile of the WHO/NCHS/CDC reference population;
(2) as percentages of the WHO/NCHS/CDC reference median; and
(3) as standard deviations from the WHO/NCHS/CDC reference median.

For example, one Ugandan boy in the data set was aged 37 months, weighed 13.2 kilograms and stood 90 cm tall. He is classified as being between the 6th and 7th centile, has a Z-score of -1.5 SDs and is 94 per cent of the reference value.

Tables 5.9, 5.10 and 5.11 show the Ht/A, Wt/A and Wt/Ht distribution of all measured children in the three countries by centiles, per cent of reference median and Z-scores. It can be seen that the first measure, centiles, is unsuitable for a detailed analysis of Ht/A

Table 5.9: HT/A, WT/A AND WT/HT OF ALL MEASURED CHILDREN BY CENTILES, PER CENT OF REFERENCE MEDIAN AND Z-SCORES: BURUNDI

	HT/A		WT/A		WT/HT	
CENTILES	%	Number	%	Number	%	Number
0.0 - 10	69.5	(1340)	64.9	(1252)	20.4	(402)
10.1 - 20	10.7	(206)	12.0	(232)	17.4	(343)
20.1 - 30	5.5	(106)	7.0	(136)	12.9	(255)
30.1 - 40	3.0	(58)	4.6	(88)	11.1	(218)
40.1 - 50	2.6	(51)	3.4	(65)	8.6	(169)
50.1 - 60	2.4	(47)	2.2	(43)	9.1	(179)
60.1 - 70	1.3	(25)	1.7	(33)	7.3	(144)
70.1 - 80	1.3	(26)	1.5	(29)	6.0	(118)
80.1 - 90	1.3	(26)	1.2	(23)	4.1	(82)
90.1 - 100	2.3	(44)	1.6	(30)	3	(61)
TOTAL	100.0	(1929)	100.0	(1931)	100.0	(1971)
PER CENT OF REFERENCE MEDIAN						
41 - 50			0.3	(6)		
51 - 60			2.0	(39)		
61 - 70			10.3	(199)	0.3	(6)
71 - 80	0.9	(17)	30.4	(587)	3.9	(76)
81 - 90	28.9	(558)	32.3	(623)	23.7	(466)
91 - 100	61.5	(1186)	16.5	(319)	42.5	(838)
101 - 110	8.0	(154)	5.3	(103)	23.3	(459)
111 - 120	0.6	(11)	2.0	(38)	5.0	(99)
121 - 130	0.2	(4)	0.6	(11)	0.8	(15)
131 - 140			0.2	(3)	0.4	(7)
140+			0.1	(1)	0.2	(3)
TOTAL	100.0	(1930)	100.0	(1929)	100.0	(1969)
Z-SCORES (STANDARD DEVIATIONS)						
Less than -5	1.7	(32)				
-4.9 to -4.0	3.9	(75)	1.6	(31)		
-3.9 to -3.0	13.8	(267)	8.8	(169)	1.0	(20)
-2.9 to -2.0	28.7	(554)	27.9	(538)	4.7	(93)
-1.9 to -1.0	29.0	(559)	35.0	(676)	25.6	(505)
-0.9 to 0.9	19.9	(384)	24.7	(476)	63.1	(1245)
1.0 to 1.9	1.8	(35)	1.6	(31)	4.4	(86)
2.0 to 2.9	0.7	(14)	0.4	(8)	0.9	(18)
3.0 to 3.9	0.2	(5)	0.0	(0)	0.2	(5)
4.0 to 4.9	0.1	(2)	0.1	(1)		
5.0 or more	0.2	(3)				
TOTAL	100.0	(1930)	100.0	(1930)	100.0	(1972)

SOURCE: As for Table 4.4.

Table 5.10: HT/A, WT/A AND WT/HT OF ALL MEASURED CHILDREN BY CENTILES, PER CENT OF REFERENCE MEDIAN AND Z-SCORES: UGANDA

	HT/A		WT/A		WT/HT	
CENTILES	%	Number	%	Number	%	Number
0.0 - 10	65.2	(2471)	46.4	(1757)	7.5	(285)
10.1 - 20	11.9	(449)	13.6	(515)	9.6	(363)
20.1 - 30	5.7	(217)	9.8	(370)	11.1	(422)
30.1 - 40	4.1	(155)	7.4	(281)	10.5	(400)
40.1 - 50	2.8	(108)	6.0	(227)	10.3	(390)
50.1 - 60	1.9	(72)	5.3	(200)	12.5	(476)
60.1 - 70	2.1	(81)	3.2	(122)	10.8	(408)
70.1 - 80	1.7	(66)	3.2	(122)	11.3	(427)
80.1 - 90	1.5	(58)	2.1	(79)	8.3	(314)
90.1 - 100	3.0	(113)	3	(116)	8	(306)
TOTAL	100.0	(3790)	100.0	(3789)	100.0	(3791)
PER CENT OF REFERENCE MEAN						
41 - 50						
51 - 60			0.7	(26)		
61 - 70			6.2	(236)	0.0	(2)
71 - 80	1.3	(50)	21.1	(800)	1.0	(38)
81 - 90	27.8	(1055)	30.2	(1145)	10.3	(391)
91 - 100	60.5	(2294)	24.9	(944)	37.7	(1429)
101 - 110	9.4	(358)	11.5	(434)	36.0	(1365)
111 - 120	0.7	(26)	3.1	(119)	11.4	(433)
121 - 130	0.2	(7)	1.5	(56)	2.8	(106)
131 - 140			0.4	(16)	0.6	(21)
141+			0.4	(16)	0.1	(6)
TOTAL	100.0	(3790)	100.0	(3792)	100.0	(3791)
Z-SCORES (STANDARD DEVIATIONS)						
Less than -5	1.5	(57)				
-4.9 to -4.0	5.3	(200)	0.5	(18)		
-3.9 to -3.0	12.4	(469)	4.4	(168)	0.1	(4)
-2.9 to -2.0	25.3	(958)	18.4	(696)	1.8	(67)
-1.9 to -1.0	28.6	(1083)	32.2	(1220)	11.2	(426)
-0.9 to 0.9	23.0	(872)	40.4	(1529)	73.7	(2792)
1.0 to 1.9	2.6	(97)	3.1	(119)	10.8	(409)
2.0 to 2.9	0.8	(31)	0.7	(27)	2.0	(77)
3.0 to 3.9	0.3	(12)	0.2	(7)	0.3	(12)
4.0 to 4.9	0.1	(3)	0.1	(3)	0.1	(3)
5.0 or more	0.2	(7)	0.1	(3)		
TOTAL	100.0	(3789)	100.0	(3790)	100.0	(3790)

SOURCE: As for Table 4.5.

Table 5.11: HT/A, WT/A AND WT/HT OF ALL MEASURED CHILDREN BY CENTILES, PER CENT OF REFERENCE MEDIAN AND Z-SCORES: ZIMBABWE

	HT/A		WT/A		WT/HT	
CENTILES	%	Number	%	Number	%	Number
0.0 - 10	54.8	(1344)	31.9	(781)	6.2	(152)
10.1 - 20	14.9	(365)	15.1	(371)	8.2	(201)
20.1 - 30	9.1	(223)	13.7	(335)	9.7	(237)
30.1 - 40	5.5	(136)	8.5	(208)	9.0	(222)
40.1 - 50	4.0	(97)	7.5	(185)	9.3	(229)
50.1 - 60	3.8	(92)	6.3	(155)	12.4	(304)
60.1 - 70	2.6	(63)	5.2	(127)	11.8	(289)
70.1 - 80	2.1	(51)	4.2	(104)	11.0	(269)
80.1 - 90	1.3	(33)	3.2	(79)	10.1	(247)
90.1 - 100	2.0	(48)	4	(107)	12	(304)
TOTAL	100.0	(2452)	100.0	(2452)	100.0	(2454)
PER CENT OF REFERENCE MEAN						
41 - 50						
51 - 60			0.2	(6)		
61 - 70			2.1	(52)	0.1	(2)
71 - 80	0.2	(6)	11.9	(291)	0.6	(15)
81 - 90	14.9	(365)	30.3	(742)	7.5	(185)
91 - 100	73.2	(1796)	32.2	(789)	34.2	(839)
101 - 110	11.2	(275)	15.4	(378)	37.6	(923)
111 - 120	0.4	(9)	4.9	(120)	15.0	(367)
121 - 130		(1)	1.8	(45)	3.1	(76)
131 - 140			0.9	(22)	1.4	(35)
141 +			0.3	(7)	0.4	(12)
TOTAL	100.0	(2452)	100.0	(2452)	100.0	(2454)
Z-SCORES (STANDARD DEVIATIONS)						
Less than -5	0.2	(6)				
-4.9 to -4.0	2.0	(49)	0.1	(3)		
-3.9 to -3.0	6.5	(159)	1.5	(38)	0.2	(6)
-2.9 to -2.0	20.5	(502)	10.0	(244)	1.1	(27)
-1.9 to -1.0	35.6	(873)	30.3	(743)	9.5	(234)
-0.9 to 0.9	32.4	(794)	51.5	(1262)	70.5	(1731)
1.0 to 1.9	2.0	(50)	5.1	(126)	14.2	(349)
2.0 to 2.9	0.4	(10)	1.1	(26)	3.1	(75)
3.0 to 3.9	0.2	(4)	0.4	(10)	1.1	(27)
4.0 to 4.9	0.1	(3)			0.2	(4)
5.0 or more	0.1	(2)			0.0	(1)
TOTAL	100.0	(2452)	100.0	(2452)	100.0	(2454)

SOURCE: As for Table 4.6.

and Wt/A in these three countries, as most of the cases fall into the first decile of the reference population. This is because there is a high prevalence of stunting in the three study populations. Even though the distribution of height within each of the study populations is approximately normal, as shown in Figures 5.4 and 5.5 and Annex Figures 1 and 2, the level is well below that of the reference population.

Hence centiles indicate that there are large numbers of children in the study populations whose growth attainment is less than that of the reference population, but give little information on the distribution of growth attainment within the study populations. In all three tables, Wt/Ht is more evenly distributed across the centiles, especially in Zimbabwe, but still this measure emphasises the pattern relative to that of the reference population, rather than the pattern of the study population.

The values for per cent of reference median are more evenly distributed in all three countries. As discussed in Section 5.2.1, this measure is most frequently used to provide a simple cut-off point to identify children significantly below the reference median, especially Wt/A. It is interesting that, in each country, the values for Ht/A are clustered more than the values for Wt/A and Wt/Ht, yet stunting is more prevalent in all three study populations than are underweight and wasting. The explanation for this is that in any population there is less variation in height than in weight. Hence a difference of 20 per cent in height between two children of the same age is considered very large, while a difference of 20 per cent in weight may not be regarded as exceptional. As a consequence of this, per cent of reference median also is limited in its utility as a measure of Ht/A.

The limitations of both centiles and per cent of reference median are overcome to a considerable extent by Z-scores. It can be seen in Tables 5.9 to 5.11 that the distribution of Z-scores for Ht/A, where there is relatively less absolute variation, is more evenly spread than per cent of reference median, and thus more suitable for identifying disadvantaged children. There is less difference between Z-scores and per cent of reference median for Wt/A and Wt/Ht, where there is a wider range of values, but Z-scores are still the preferred standardized measure.

5.3.4 Cut-off points

There has been much discussion of the utility and limitations of anthropometric cut-off points to determine the proportion of any sample population that might be at risk. As discussed in Section 5.2.1, cut-off points are widely used in conjunction with cross-sectional surveys as a quick way of identifying cases for intervention programs. The cut-off point may be determined arbitrarily, depending on the availability of resources for the program. A commonly selected cut-off is 2 SDs below the reference median (-2 SDs), but if fewer resources are available a lower cut-off such as -2.5 SDs may be selected (WHO, 1983: 25; Beaton et al., 1990: 49).

Minus 2 SDs is also a popular choice of cut-off point for the analysis of anthropometric patterns (a few of the many examples that might be cited are Zerfas, 1989; Gaminiratne, 1991; World Bank, 1991). However, although use of a cut-off is essential in some circumstances to facilitate data management and interpretation, it implies that there are real differences between children on either side. WHO (1986) argues convincingly that the conventional cut-off points, -2 SDs and 80 per cent of the reference median, may be unrealistic and of limited use. Even in a practical situation, they should always be customized as they are, at best, a short-hand method of determining relative need.

One obvious drawback to the use of cut-off points is that different scales of measurement may focus on different cases. For example, 80 per cent of the reference median is roughly equivalent to a Z-score of -2 SDs but the relative proportions of children diagnosed as malnourished by the two indicators changes with age (Waterlow et al., 1977: 494). Keller and Fillmore (1983) found that 27 per cent of a sample of children aged between one and two years old had a Wt/Ht Z-score of -2 SDs or below, but only 15 per cent were below 80 per cent of the reference median. Similarly, Mora (1985) used different data to demonstrate that the actual cases identified by cut-off points for the various indices differ.

Table 5.12 compares the cases identified as disadvantaged by the three measures. It confirms the above observations on the variability of the proportions identified by the two indicators, per cent of reference median and a Z-score of -2 SDs. In all three data sets it can be seen that, whereas Z-scores identify a much greater proportion of stunted children than per cent of reference median, the latter identifies slightly more underweight children. The proportions in the 1st decile exceed both the proportions less than -2 SDs and those below 80 per cent of the reference median, in almost all cases. A lower cut-off of the 3rd or 5th centile identifies similar proportions to the Z-score.

In a subsequent paper, Mora (1989) proposed a new method of estimating a standardized prevalence of child malnutrition. This method is based on comparing the observed population distribution with the distribution of the reference population, and subtracting false positives and adding false negatives to the measured prevalence. False

Table 5.12: COMPARISON OF CENTILES, PER CENT OF REFERENCE MEDIAN AND Z-SCORES FOR HT/A, WT/A AND WT/HT: BURUNDI UGANDA AND ZIMBABWE (per cent)

	3rd Centile or less		-2 SDs or less		80 % of reference median	
	%	Number	%	Number	%	Number
BURUNDI						
Ht/A	51.5	(995)	48.1	(928)	0.9	(17)
Wt/A	42.2	(814)	38.3	(738)	43	(830)
Wt/Ht	7.5	(144)	5.7	(110)	4.1	(80)
UGANDA						
Ht/A	48.2	(1825)	44.4	(1684)	1.3	(50)
Wt/A	26.5	(1004)	23.3	(882)	28	(1061)
Wt/Ht	2.4	(90)	1.9	(71)	1.1	(40)
ZIMBABWE						
Ht/A	33.6	(825)	29.2	(716)	0.2	(6)
Wt/A	13.8	(339)	11.6	(285)	14.2	(349)
Wt/Ht	1.8	(43)	1.3	(33)	0.7	(17)

SOURCE: As for Tables 4.4, 4.5 and 4.6.

positives are defined as the excess cases above the cut-off point in the observed compared to the reference population, and false negatives the excess below the cut-off point. This method could improve prevalence estimates at the population level, but is not applicable to the assessment of individual nutritional status, nor to an exploration of the correlates of nutritional status.

Despite their limitations, cut-off points are useful as pointers to cases that may be in need of intervention when it is necessary to allocate food resources. They are also useful for making a preliminary classification to identify important variables, but they are no more than an approximate measure. In the absence of longitudinal data to indicate trends over time, they should never be regarded as making a definitive statement about the condition of individual children.

A more practical approach to a detailed analysis of anthropometric patterns is to treat anthropometric indicators as continuous variables, and to focus on patterns of covariation. One argument advanced by some in favour of cut-off points and bi-variate analysis (for example, Gaminiratne, 1991), is that their data are too unreliable to use at the individual level. However, this approach still makes the questionable assumption that the data are sufficiently reliable to allow meaningful classification to either side of a cut-off point. Moreover, although cases may be reclassified into two groups, statistical procedures for analyzing growth attainment operate on individual cases.

The foregoing exploration of the DHS Burundi, Uganda and Zimbabwe data sets depicts patterns and distributions which indicate that the anthropometric data are plausible. Although they no doubt include some measurement errors from the various sources discussed above, there is nothing to suggest that they are too inaccurate to be treated as continuous variables, or that this approach is less valid than a bi-variate analysis using cut-off points. It is therefore recommended that anthropometric indicators should be treated as continuous variables whenever possible, to avoid loss of information and give the best picture of patterns of growth attainment. Both approaches will be used in Chapter Six, so that the results, advantages and disadvantages of the two methods can be compared.

5.3.5 Z-score distributions

The Z-score is used for the remainder of this analysis for several reasons. First, it is the most appropriate measure for data sets such as those for Burundi, Uganda and Zimbabwe, where substantial proportions of children are stunted and wasted, but where the samples as a whole are close to normally distributed. Second, the Z-score focuses attention on cases at the extremes of the range while grouping those cases which are close to the median. Finally, as WHO (1986: 939) points out, the coefficient of measurement variation differs with age. Whereas Z-scores allow for this, per cent of reference median does not.

Tables 5.13, 5.14 and 5.15 show the percentages of all children by age group, according to Z-score range for the three countries. The fifth column of each table totals the percentage below the conventional cut-off point -2 SDs. It can be seen that the patterns are similar in all three countries, although the percentages vary substantially. In each case there are more extreme cases for Ht/A than for Wt/A, and more extreme cases for Wt/A than for Wt/Ht.

When the -2 SD cut-off point is used to classify children as stunted, underweight or wasted, it can be seen that not only is there a wider range of Ht/A Z-scores, but also the percentage stunted is much higher than the percentages underweight or wasted. Forty-eight per cent of measured Burundais singletons are stunted, 44 per cent in Uganda and 29 per cent in Zimbabwe, but only 38 per cent, 23 per cent and 11 per cent respectively

Table 5.13: HT/A, WT/A AND WT/HT DISTRIBUTION OF MEASURED CHILDREN, Z-SCORES: BURUNDI (per cent)

	low to -5SD	-4.9 to -4SD	-3.9 to -3SD	-2.9 to -2SD	TOTAL -2SD	-1.9 to -1SD	-.99 to +.9SD	1 to 1.9SD	2 to 2.9SD	3 to 3.9SD	4 to 4.9SD	5SD +	Total *	n
All singletons														
Ht/A	1.6	3.9	13.6	28.8	[illegible]	29.1	20.0	1.8	0.7	0.2	0.1	0.2	100.0	1906
Wt.A		1.5	8.7	27.7	[illegible]	35.1	24.9	1.6	0.4	0.0	0.1		100.0	1906
Wt/Ht			1	4.7	[illegible]	25.5	63.2	4.4	0.9	0.2	0.0		99.9	1947
3 - 11 months														
Ht/A	0.9	1.8	8	22.9	[illegible]	33.0	28.5	2.9	1.0	0.2	0.4	0.5	100.1	654
Wt.A		2.1	6.2	19.2	27.5	31.5	37.1	2.8	0.9	0.0	0.2		100.0	654
Wt/Ht			0.7	3.2	[illegible]	20.9	64.7	7.9	2.0	0.5			99.9	657
12 - 23 months														
Ht/A	1.5	2.7	15.2	28.5	47.9	31.4	17.8	1.6	1.0	0.2			99.9	604
Wt.A		1.3	10.2	30.6	42.1	36.5	19.8	1.4	0.1				99.9	604
Wt/Ht			1.7	8.4	10.1	34.4	52.4	2.6	0.2	0.2			99.9	618
24 - 36 months														
Ht/A	2.5	7	17.6	35.1	62.2	22.9	13.5	0.9	0.3	0.2			100.0	647
Wt.A		1.1	9.8	33.7	44.6	37.4	17.3	0.6	0.1				100.0	647
Wt/Ht			0.7	2.8	3.5	21.8	71.7	2.6	0.4				100.0	672
Multiple births (aged 3-36 months)														
Ht/A		9.7	33.9	24.2	67.8	16.1	8.1			8.1			100.1	14
Wt.A			17.8	50	67.8	16.1	8.1	8.1					100.1	14
Wt/Ht				7.9	7.9	33.3	57.1	1.7					100.0	15

* Percentages may not sum to 100 due to rounding

SOURCE: As for Table 4.4.

Table 5.14: HT/A, WT/A AND WT/HT DISTRIBUTION OF MEASURED CHILDREN, Z-SCORES: UGANDA (per cent)

	low to -5SD	-4.9 to -4SD	-3.9 to -3SD	-2.9 to -2SD	TOTAL -2SD or less	-1.9 to -1SD	-.99 to +.9SD	1 to 1.9SD	2 to 2.9SD	3 to 3.9SD	4 to 4.9SD	5SD +	Total *	n
All singletons														
Ht/A	1.4	5.1	12.1	25.2	[illegible]	28.9	23.4	2.5	0.8	0.3	0.1	0.2	100	3691
Wt/A		0.4	4.1	18.2	22.7	32.2	40.9	3.1	0.7	0.2	0.1	0.1	100	3691
Wt/Ht			0.1	1.6	1.7	11.4	73.6	10.8	2.0	0.3	0.1		100	3692
3 - 11 months														
Ht/A	0.4	0.7	3.8	16.8	21.7	35.4	37.4	3.5	1.0	0.3	0.1	0.4	100	971
Wt/A		0.3	1.7	12.0	14.0	28.0	49.0	6.3	2.0	0.5	0.1	0.2	100	971
Wt/Ht			0.3	0.5	[illegible]	11.6	67.2	16.3	2.8	1.0	0.3		100	972
12 - 23 months														
Ht/A	1.5	6.0	12.8	32.0	[illegible]	26.9	17.9	1.9	0.4	0.5	0.1	0.1	100	834
Wt/A		0.8	7.7	22.3	[illegible]	36.2	30.0	2.0	0.6	0.2	0.1	0.1	100	834
Wt/Ht				3.8	[illegible]	20.6	66.7	7.1	1.7	0.1			100	834
24 - 35 months														
Ht/A	2.3	7.7	15.8	26.4	52.2	26.4	16.4	2.5	1.7	0.3	0.2	0.3	100	696
Wt/A		0.9	6.2	19.9	27.0	29.1	41.1	2.2	0.2	0.1	0.2	0.1	100	696
Wt/Ht			0.1	1.5	[illegible]	7.7	81.1	7.7	1.7	0.2			100	696
36 - 47 months														
Ht/A	1.6	6.4	16.1	27.5	[illegible]	26.4	19.0	2.0	0.7	0.3			100	644
Wt/A		0.1	2.4	19.0	21.5	34.7	41.4	2.4					100	644
Wt/Ht				1.0	1.0	7.9	77.8	11.7	1.6				100	644
48 - 60 months														
Ht/A	1.7	6.6	16.2	25.4	[illegible]	26.5	21.0	2.5	0.1	0.1			100	546
Wt/A			2.4	19.6	22.0	34.3	42.3	1.3	0.1				100	546
Wt/Ht				1.3	[illegible]	5.7	81.1	9.8	2.1				100	546
Multiple births (aged 0-60 months)														
Ht/A	8.1	8.9	27.1	28.5	72.6	11.0	8.2	4.1	4.1				100	40
Wt/A		4.1	17.6	24.5	46.2	27.2	22.5	4.1					100	40
Wt/Ht				8.1	8.1	9.5	71.5	10.9					100	40

SOURCE: As for Table 4.5.

Table 5.15: HT/A, WT/A AND WT/HT DISTRIBUTION OF MEASURED CHILDREN, Z-SCORES: ZIMBABWE (per cent)

	low to -5SD	-4.9 to -4SD	-3.9 to -3SD	-2.9 to -2SD	TOTAL -2SD or less	-1.9 to -1SD	-.99 to +.9SD	1 to 1.9SD	2 to 2.9SD	3 to 3.9SD	4 to 4.9SD	5SD +	Total *	n
All singletons														
Ht/A	0.3	2.1	6.1	20.1	28.6	35.7	32.9	2.1	0.4	0.2	0.1	0.1	100.1	2362
Wt.A		0.1	1.4	9.8	11.3	30.0	51.9	5.2	1.1	0.4			99.9	2362
Wt/Ht			0.3	1.1	1.4	9.4	70.6	14.2	3.2	1.1	0.2	0.0	100.1	2364
3 - 11 months														
Ht/A		0.9	2.6	13.6	17.1	31.8	47.2	2.8	0.7	0.5			100.1	428
Wt.A			0.5	5.4	5.9	17.1	57.9	14.5	3.5	1.2			100.1	428
Wt/Ht				0.5	0.5	4.9	52.8	26.6	10.5	4.2	0.5		100.0	428
12 - 23 months														
Ht/A		2.2	6.2	26.0	34.4	40.6	21.9	1.7	0.6	0.2	0.4	0.2	100.0	535
Wt.A			1.3	13.6	14.9	36.6	42.1	5.2	0.4	0.7			99.9	535
Wt/Ht			0.2	1.7	1.9	14.8	67.7	12.1	2.6	0.6	0.4		100.1	535
24 - 35 months														
Ht/A		0.6	2.2	8.1	10.9	23.7	34.2	28.9	1.8	0.4	0.2		100.1	506
Wt.A		0.2	2.4	12.6	15.2	29.2	53.0	2.2	0.2	0.2			100.0	506
Wt/Ht			0.6	0.4	1.0	7.9	78.5	11.4	1.0			0.2	100.0	507
36 - 47 months														
Ht/A	0.5	3.5	8.4	20.8	33.2	32.9	31.1	2.1	0.5	0.2			100.0	428
Wt.A			1.9	9.3	11.2	32.5	54.0	1.4	0.9				100.0	428
Wt/Ht				1.4	1.4	9.1	75.3	12.6	0.9	0.7			100.0	428
48 - 60 months														
Ht/A	0.2	1.5	4.7	14.6	21.0	38.1	38.7	2.2					100.0	465
Wt.A		0.4	1.1	6.7	8.2	32.7	54.6	3.7	0.9				100.1	465
Wt/Ht			0.4	1.5	1.9	9.2	77.4	9.5	1.5	0.4			99.9	465
Multiple births (aged 3-60 months)														
Ht/A			13	34.8	47.8	34.8	17.4						100.0	46
Wt.A			2.2	10.9	13.1	47.8	39.1						100.0	46
Wt/Ht					0.0	10.9	80.4	8.7					100.0	46

* Percentages may not sum to 100 per cent due to rounding

SOURCE: As for Table 4.6.

are underweight. Wasting is a relatively rare occurrence in all three countries, with only 6 per cent in Burundi, 2 per cent in Uganda and a little over 1 per cent in Zimbabwe. Predictably, in each country multiple births are consistently disadvantaged compared with singletons, except for Wt/Ht in Zimbabwe.

It is interesting to note that earlier studies of growth attainment of Burundais children aged 0-59 months, rather than 3-36 months, show similar levels of stunting, underweight and wasting, although there is some variation between regions. Of 838 children surveyed in 1983, 50 per cent were stunted, 30 per cent underweight and 3 per cent wasted (FAO, 1987b: 7). In Buyenzi, one of the townships in Bujumbura, a 1985 survey found 61 per cent of children stunted, 52 per cent underweight and 12 per cent wasted (FAO, 1987b: 7).

Tables 5.13, 5.14 and 5.15 also show that the incidence of stunting, underweight and wasting changes with age in each of the countries. In Uganda and Zimbabwe children aged 13-24 months and 25-36 months are most disadvantaged for all three indicators, but Z-scores improve for older children. Burundi also shows a gradual deterioration of Z-scores with age, with a startling 62 per cent of children aged 25-36 months classified as stunted and 45 per cent underweight. As no children aged over 36 months were measured in Burundi, Table 5.13 does not show an improvement for older children. However, it is likely that the pattern would be similar to those of Uganda and Zimbabwe.

Plots of the Z-score overall distributions for the three countries are compared in Figures 5.7, 5.8 and 5.9. It is apparent that the plots for Ht/A and Wt/A for all three countries are displaced to the left of the reference median. Zimbabwe appears slightly advantaged in both plots compared to Burundi and Uganda. Figure 5.9, which plots Wt/Ht, is interesting in that the patterns for all three countries are close to a normal distribution. The modes for both Uganda and Zimbabwe are close to zero, with that for Burundi a little less, at -0.75 SDs.

The Z-scores for all measured male and female singletons and multiple births within each country are presented in Annex Figures 3, 4 and 5. The patterns for the three countries are fairly consistent, with the exception of multiple births, which are erratic. In all three countries, for both males and females, the curve for Ht/A is displaced furthest to the left, reflecting the prevalence of stunting, Wt/Ht is furthest to the right and Wt/A intermediate. Ht/A peaks well below the reference median, but Wt/Ht peaks close to, or even above, the reference median. It is also noticeable that the curves for Wt/Ht have

Figure 5.7: DISTRIBUTION OF HT/A, AGES 3 - 36 MONTHS: BURUNDI, UGANDA AND ZIMBABWE

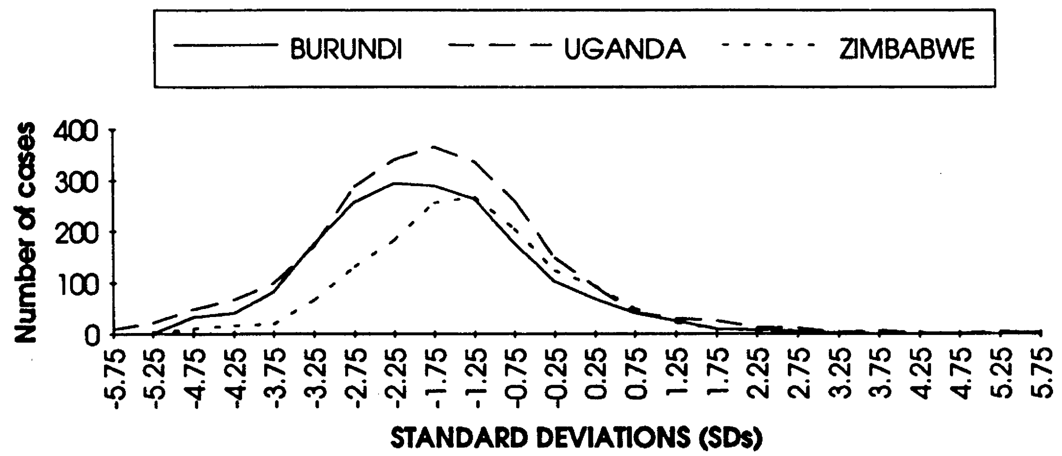


Figure 5.8: DISTRIBUTION OF WT/A, AGES 3-36 MONTHS: BURUNDI, UGANDA AND ZIMBABWE

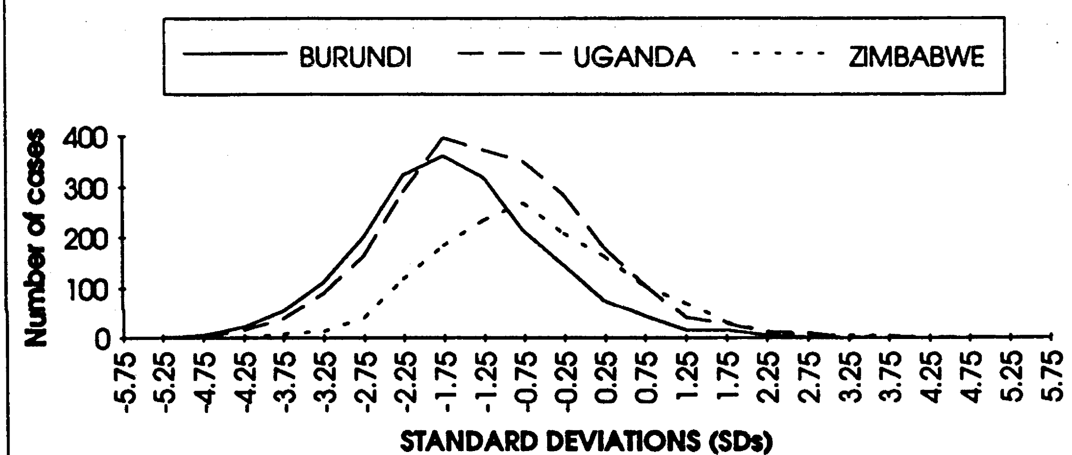
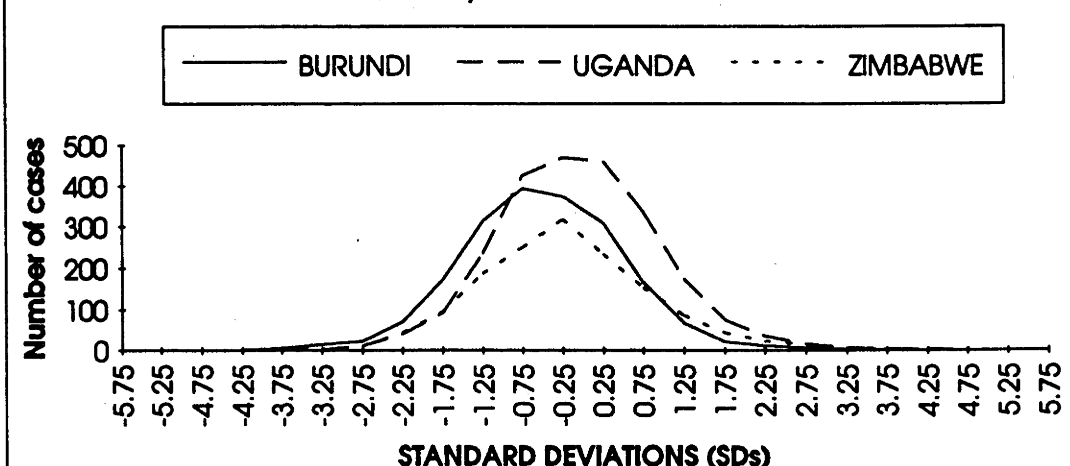


Figure 5.9: DISTRIBUTION OF WT/HT, AGES 3 - 36 MONTHS: BURUNDI, UGANDA AND ZIMBABWE



Source: As for Tables 4.4, 4.5 and 4.6.

steeper peaks, with fewer cases in the tails to either side, while those for Ht/A and Wt/A are closer to a normal distribution. In Burundi there tends to be little difference in the pattern of Ht/A, Wt/A and Wt/Ht scores for male children, but there is a marked difference for females. This suggests that male children are more susceptible to wasting in this country. In contrast, in Uganda and Zimbabwe, Ht/A and Wt/A scores are noticeably lower than those for Wt/Ht for both sexes.

These patterns signify that height attainment of children in all three countries is substantially below that of the reference population, weight attainment is somewhat less, but Wt/Ht is not very different. That is, although the children tend to be small, their weight tends to be appropriate for their height.

As discussed above, it is generally agreed that, up to age five years, children of all ethnic groups have approximately the same potential for growth. Differences between populations are largely due to differing nutrition and environment rather than to ethnicity (Habicht, 1974b; Eveleth and Tanner, 1976; Falkner, 1985). In view of this, it can be hypothesized that if the main causes of growth failure are nutritional and environmental rather than genetic, Z-scores would be close to the reference values at birth and then decline progressively with age. On the other hand, if the study population were simply genetically smaller than the reference population the Z-scores should remain relatively constant.

Tables 5.16, 5.17 and 5.18 test this hypothesis with a regression of Ht/A, Wt/A and Wt/Ht Z-scores with age for all singleton births, separately for each sex and for multiple births. It can be seen that, with the exception of multiple births, which are again highly erratic, there is almost always a significant or highly significant negative relationship of Z-score with age. In most cases the decline in Z-score values with age in months was so small that the b_1 values in the tables have been presented to four decimal places to allow differences to be distinguished. Nonetheless, in most cases they sum to around 0.3 SDs or 0.4 SDs for every year of age. The deterioration tends to be a little greater for females than for males, although females tend to have a higher constant value, suggesting a more favourable position relative to males early in life. It is also noticeable that the decline in Z-score values with age is sharper for the narrower age groups for Uganda and Zimbabwe (up to 36 months), and slows when the wider age groups are considered (up to 60 months).

The deterioration in Ht/A is greater for Burundais and Ugandan children up to 36 months, and least for Zimbabweans, but the position is reversed for Wt/A. Interestingly,

Table 5.16: REGRESSION OF HT / A WITH AGE: BURUNDI, UGANDA AND ZIMBABWE

	HT/A Constant	HT/A b1.AGE	Adj r2	HT/A S.E.	Signif T	Number
BURUNDI (3-36 months)						
Singletons						
Males	-1.1876	-0.0393	0.0736	1.3491	p=<0.001	(967)
Females	-0.9758	-0.0443	0.0862	1.1416	p=<0.001	(939)
All	-1.0834	-0.0418	0.0801	1.3810	p=<0.001	(1906)
Multiple births	-2.9592	0.0204	0.0367	2.0162	n.s.	(24)
UGANDA (3-36 months)						
Singletons						
Males	-1.2989	-0.0309	0.0415	1.4054	p=<0.001	(1117)
Females	-0.9310	-0.0380	0.0567	1.5040	p=<0.001	(1209)
All	-1.1084	-0.0345	0.0493	1.4622	p=<0.001	(2325)
Multiple births	-2.3138	-0.0017	0.0170	1.3177	p=<0.001	(61)
ZIMBABWE (3-36 months)						
Singletons						
Males	-1.0277	-0.0217	0.0294	1.2107	p=<0.001	(719)
Females	-0.7431	-0.0292	0.0447	1.2511	p=<0.001	(750)
All	-0.8832	-0.0254	0.0376	1.2332	p=<0.001	(1469)
Multiple births	-1.7714	-0.0061	0.0180	0.9709	p=<0.001	(45)
UGANDA (3-60 months)						
Singletons						
Males	-1.5605	-0.0134	0.0240	1.4051	p=<0.001	(1735)
Females	-1.2774	-0.1636	0.0298	1.5173	p=<0.001	(1781)
All	-1.4121	-0.0151	0.0277	1.4662	p=<0.001	(3515)
Multiple births	-2.0397	-0.0181	0.0288	1.6513	n.s.	(97)
ZIMBABWE (3-60 months)						
Singletons						
Males	-1.3262	-0.0035	0.0014	1.2188	n.s	(1185)
Females	-1.1917	-0.0427	0.0024	1.2569	n.s.	(1177)
All	-1.2564	-0.0040	0.0024	1.2387	p=<0.01	(2362)
Multiple births	-1.7608	-0.0051	0.0048	1.0263	n.s.	(90)

n.s. = Not Significant

SOURCE: As for Tables 4.4, 4.5 and 4.6.

Table 5.17: REGRESSION OF WT / A WITH AGE: BURUNDI, UGANDA AND ZIMBABWE

	WT/A Constant	WT/A b1.AGE	Adj r2	WT/A S.E.	Signif T	Number
BURUNDI (3-36 months)						
Singletons						
Males	-1.1149	-0.0278	0.0532	1.1330	p=<0.001	(967)
Females	-1.0406	-0.0289	0.0603	1.1118	p=<0.001	(939)
All	-1.0785	-0.0283	0.0570	1.1223	p=<0.001	(1906)
Multiple births	-3.6587	0.0597	0.1449	1.1554	p=<0.05	(24)
UGANDA (3-36 months)						
Singletons						
Males	-0.9985	-0.0122	0.0084	1.2051	p=<0.01	(1117)
Females	-0.6689	-0.0237	0.0323	1.2528	p=<0.001	(1209)
All	-0.8263	-0.0182	0.0197	1.2324	p=<0.001	(2325)
Multiple births	-1.7649	-0.0020	0.0169	1.1807	n.s.	(61)
ZIMBABWE (3-36 months)						
Singletons						
Males	-0.0699	-0.0315	0.0675	1.1512	p=<0.001	(719)
Females	0.0702	-0.0380	0.0903	1.1260	p=<0.001	(750)
All	-0.0010	-0.0346	0.7905	1.1381	p=<0.001	(1469)
Multiple births	0.8136	-0.0159	0.0063	1.0526	n.s.	(45)
UGANDA (3-60 months)						
Singletons						
Males	-1.1232	-0.0030	0.0013	1.1413	n.s.	(1735)
Females	-0.9532	-0.0519	0.0044	1.2053	p=<0.01	(1781)
All	-1.0343	-0.0042	0.0032	1.1752	p=<0.001	(3515)
Multiple births	-1.6344	-0.0044	0.0065	1.2709	n.s.	(97)
ZIMBABWE (3-60 months)						
Singletons						
Males	-0.4127	-0.0104	0.0236	1.0934	p=<0.001	(1185)
Females	-1.1917	-0.0043	0.0024	1.2569	n.s.	(1177)
All	-0.4066	-0.0105	0.0242	1.1007	p=<0.001	(2362)
Multiple births	-1.0865	-0.0024	0.0090	0.9676	n.s.	(90)

n.s. = Not Significant

SOURCE: As for Tables 4.4, 4.5 and 4.6.

Table 5.18: REGRESSION OF WT / HT WITH AGE: BURUNDI, UGANDA AND ZIMBABWE

	Wt/Ht Constant	Wt/Ht b1.AGE	Adj r2	Wt/Ht S.E.	Signif T	Number
BURUNDI (3-36 months)						
Singletons						
Males	-0.2535	-0.0148	0.0199	0.9819	p=<0.001	(990)
Females	-0.2428	-0.0138	0.0182	0.9660	p=<0.001	(957)
All	-0.2484	0.0143	0.0196	0.9737	p=<0.001	(1947)
Multiple births	-1.3911	0.0259	0.0297	0.8737	n.s.	(24)
UGANDA (3-36 months)						
Singletons						
Males	-0.0194	-0.0023	0.0003	0.4318	p=<0.001	(1117)
Females	0.1635	-0.0120	0.0121	1.0273	p=<0.001	(1209)
All	0.0772	-0.0075	0.0048	0.9929	p=<0.001	(2326)
Multiple births	0.2986	-0.0309	0.0582	0.9383	p=<0.05	(61)
ZIMBABWE (3-36 months)						
Singletons						
Males	0.8636	-0.0294	0.0703	1.0522	p=<0.001	(720)
Females	0.8456	-0.0320	0.0754	1.0452	p=<0.001	(750)
All	0.8519	-0.0306	0.0731	1.0486	p=<0.001	(1470)
Multiple births	0.7691	-0.0308	0.0769	1.0676	p=<0.05	(45)
UGANDA (3-60 months)						
Singletons						
Males	-0.0762	0.0022	0.0010	0.9136	n.s.	(1735)
Females	-0.0269	0.0012	0.0001	0.9739	n.s.	(1781)
All	-0.0506	0.0017	0.0006	0.9445	n.s.	(3516)
Multiple births	0.0115	-0.0064	0.0041	0.9715	n.s.	(97)
ZIMBABWE (3-60 months)						
Singletons						
Males	0.5863	-0.0124	0.0403	0.9951	p=<0.001	(1186)
Females	0.5229	-0.0193	0.0366	1.0131	p=<0.001	(1178)
All	0.5535	-0.0122	0.0386	1.0040	p=<0.001	(2364)
Multiple births	0.2477	-0.0053	0.0040	0.9972	n.s.	(90)

n.s. = Not Significant

SOURCE: As for Tables 4.4, 4.5 and 4.6.

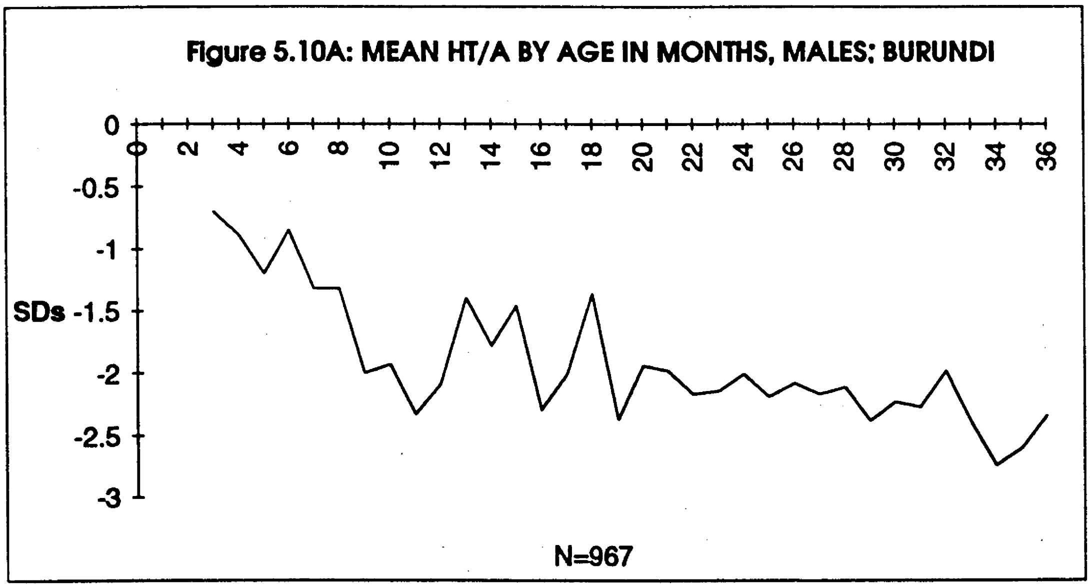
Zimbabwe has noticeably higher constant values for Wt/A than Burundi and Uganda, suggesting children are heavier in early life, whereas there is little difference in constants for Ht/A in the three countries.

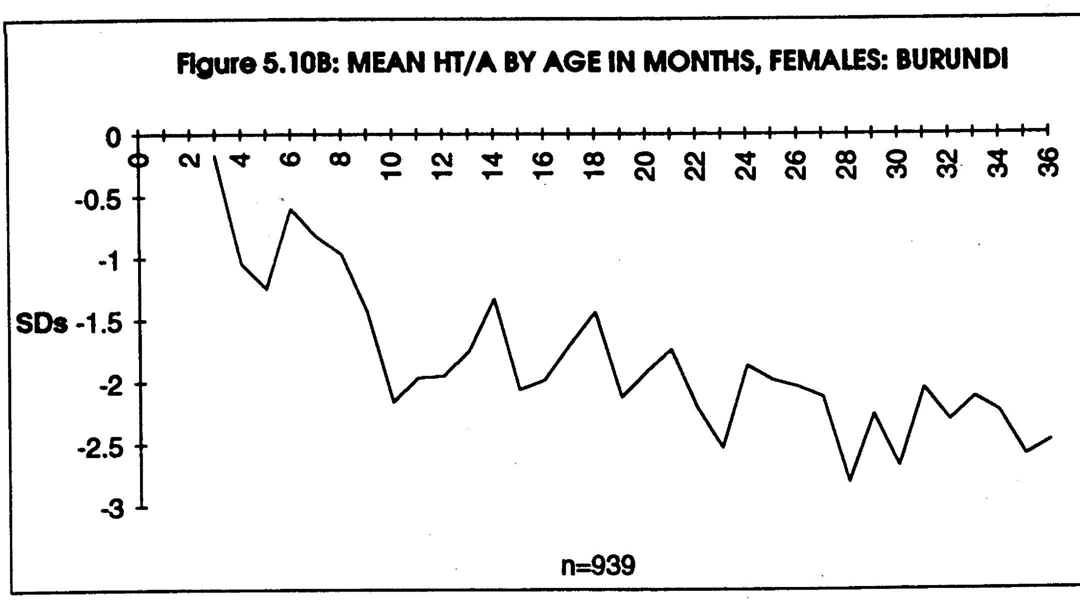
All constants are positive for Wt/Ht for Zimbabwe, but slightly negative for Burundi and Uganda, indicating a steeper slope and more rapid deterioration. However, the deterioration in growth attainment with age is greater for Zimbabwean children up to 36 months compared with both Burundais and Ugandan children in this age group. Ugandan children in the wider age group, 3-60, months actually show an improvement in their Wt/Ht attainment over time, while that of Zimbabwean children in this age group deteriorates slightly. Consistently low r^2 values indicate that age explains less than 10 per cent of the variation in Z-scores in every case, thus supporting the view of writers such as Habicht et al. (1974b) and Pelletier (1991) that environmental and socio-economic factors are more important than genetic factors.

Figures 5.10 to 5.15 plot the mean Ht/A and Wt/A Z-scores by age in months for the three countries, separately for males and females. Wt/Ht is not plotted because, in all three countries, the distribution is close to normal. It can be seen that, in each case, the Ht/A and Wt/A values for the youngest measured children are close to, or even above, the reference median, but deteriorate sharply over the succeeding 12 or so months. In Burundi, males aged three months are noticeably disadvantaged in Ht/A compared with females of that age, but there are more troughs in the female curve at ages 20-30 months. Females aged three months are also slightly better off than males in terms of Wt/A, but the pattern at older ages is fairly similar.

There are no obvious differences between male and female patterns in Uganda. It is interesting to note that all four curves for Uganda, which include children aged 0-2 months, commence above the reference median. However, deterioration is rapid and by age two months all curves have dipped below the reference median.

A surprising feature of Figures 5.10 and 5.15 for Zimbabwe is that, whereas Ht/A for both males and females is well below the reference median by age three months, Wt/A stays above or very near the reference median until age eight months. After that it plunges sharply for both sexes, then hovers between -0.5 SDs and -1.5 SDs. Both Ht/A and Wt/A tend to improve close to age 60 months, and generally Zimbabwean children appear relatively better off than those in Burundi and Uganda.





SOURCE: As for Table 4.4.

Figure 5.11A: MEAN WT/A BY AGE IN MONTHS, MALES: BURUNDI

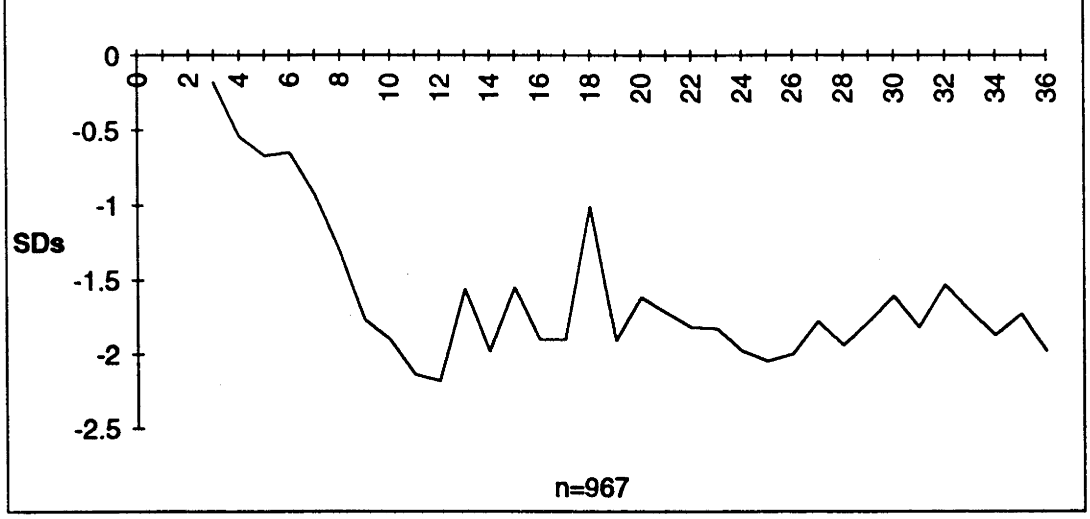
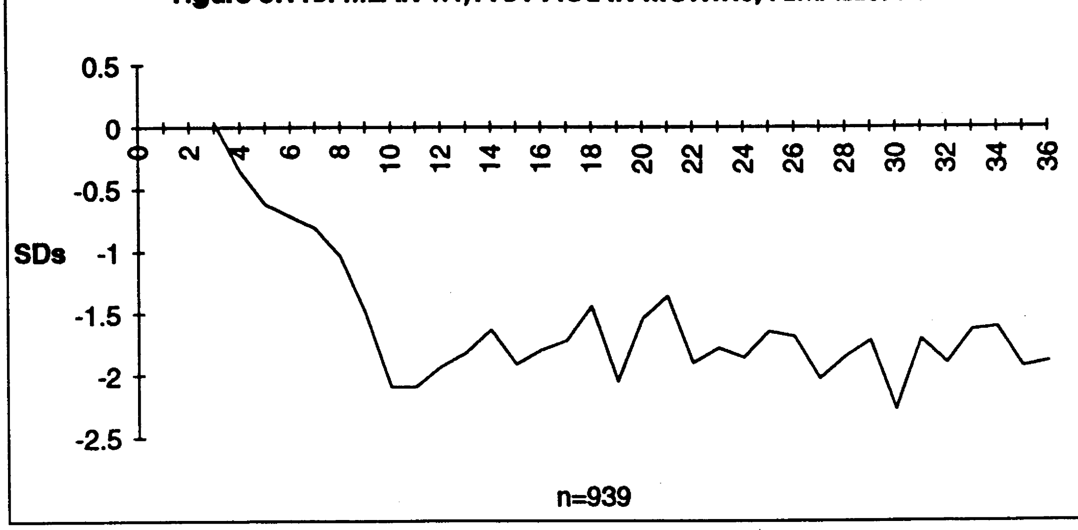
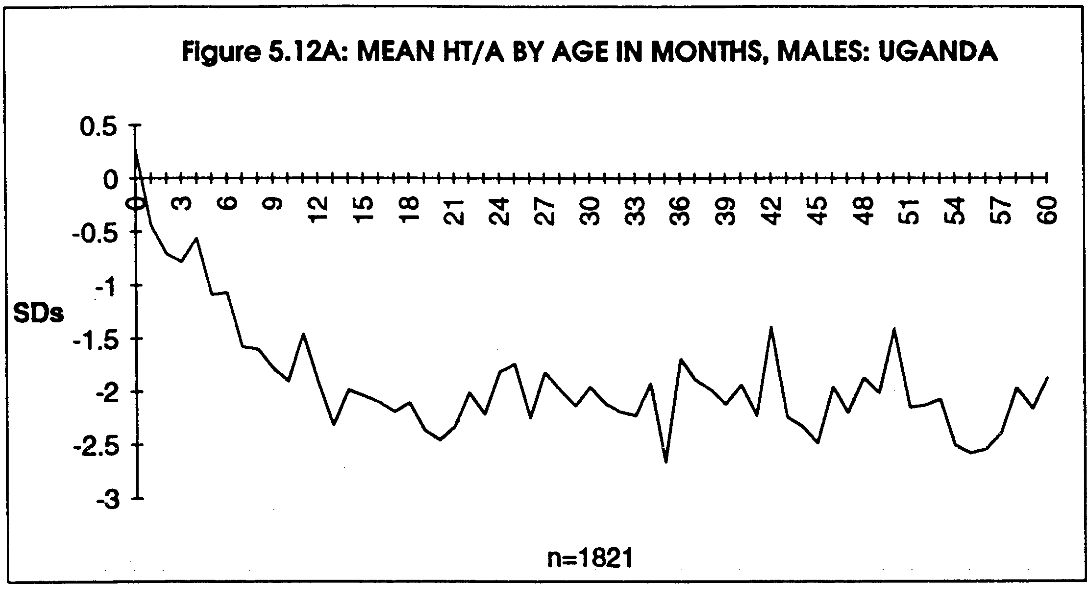
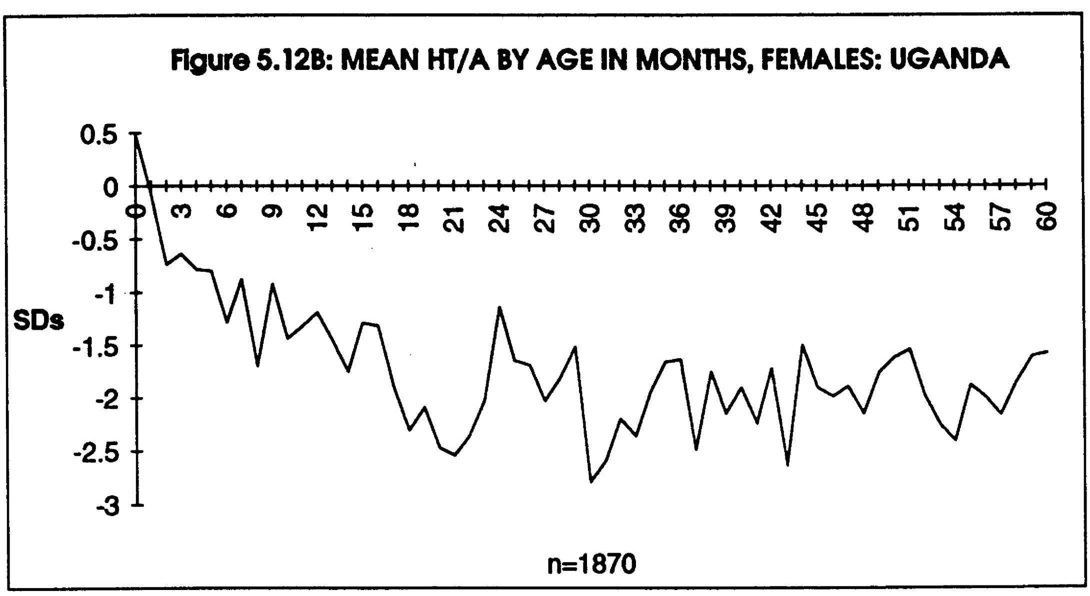


Figure 5.11B: MEAN WT/A BY AGE IN MONTHS, FEMALES: BURUNDI

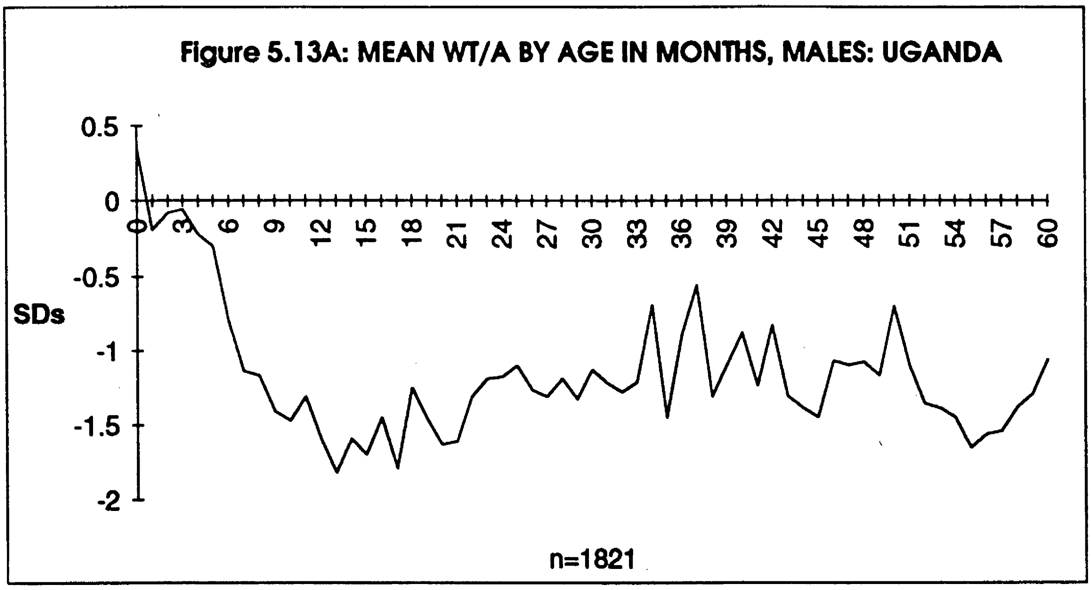


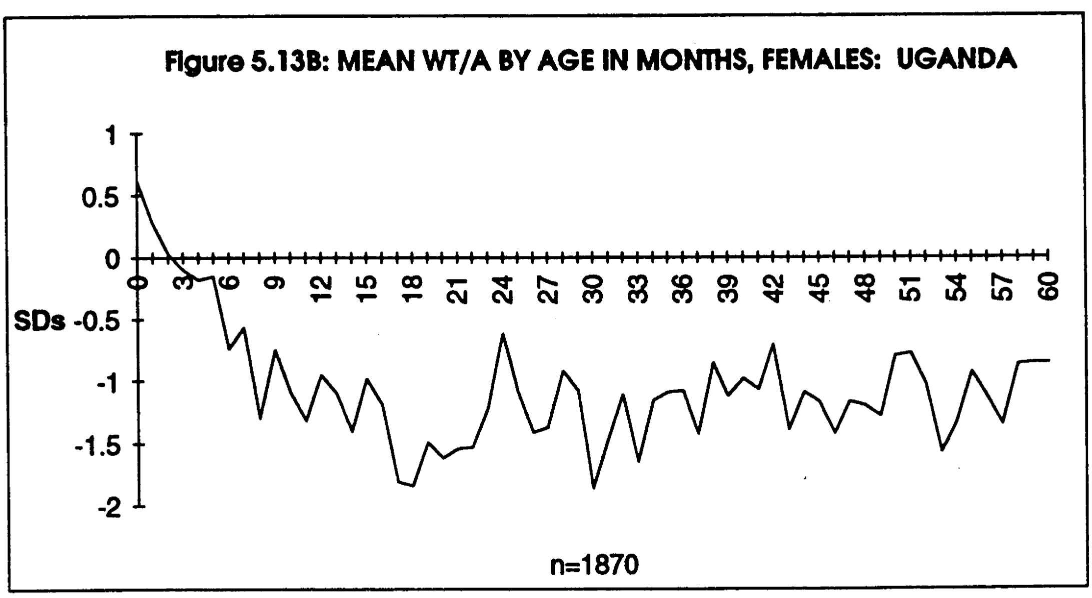
SOURCE: As for Table 4.4.





SOURCE: As for Table 4.5.





SOURCE: As for Table 4.5.

Figure 5.14A: MEAN HT/A BY AGE IN MONTHS, MALES: ZIMBABWE

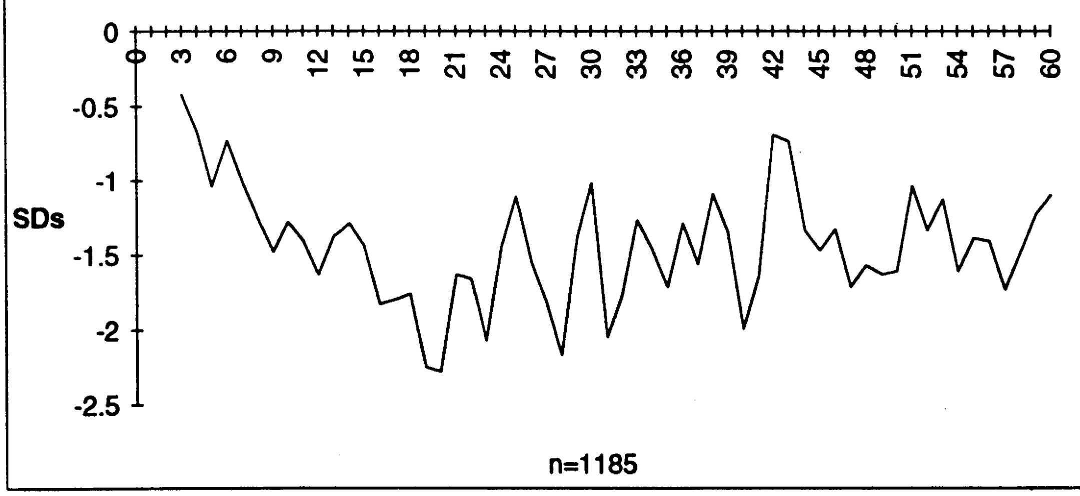
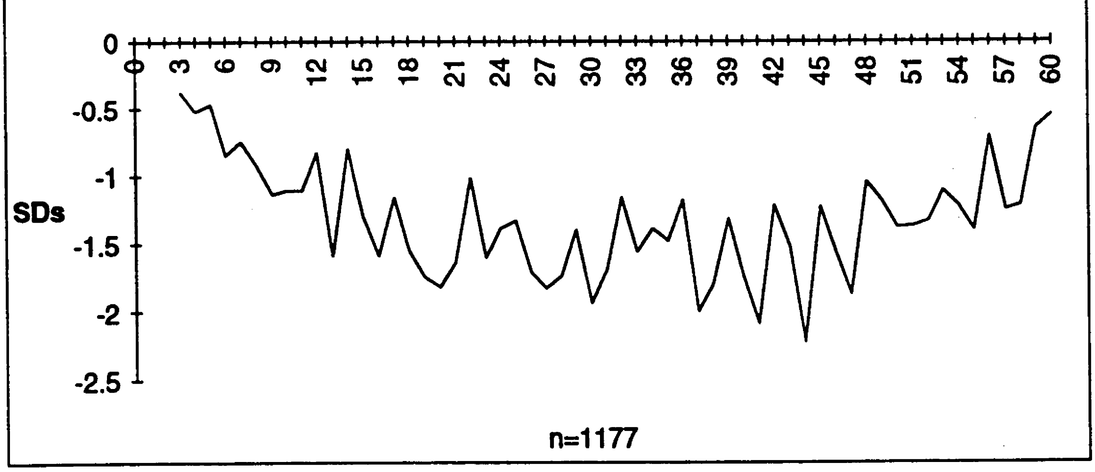
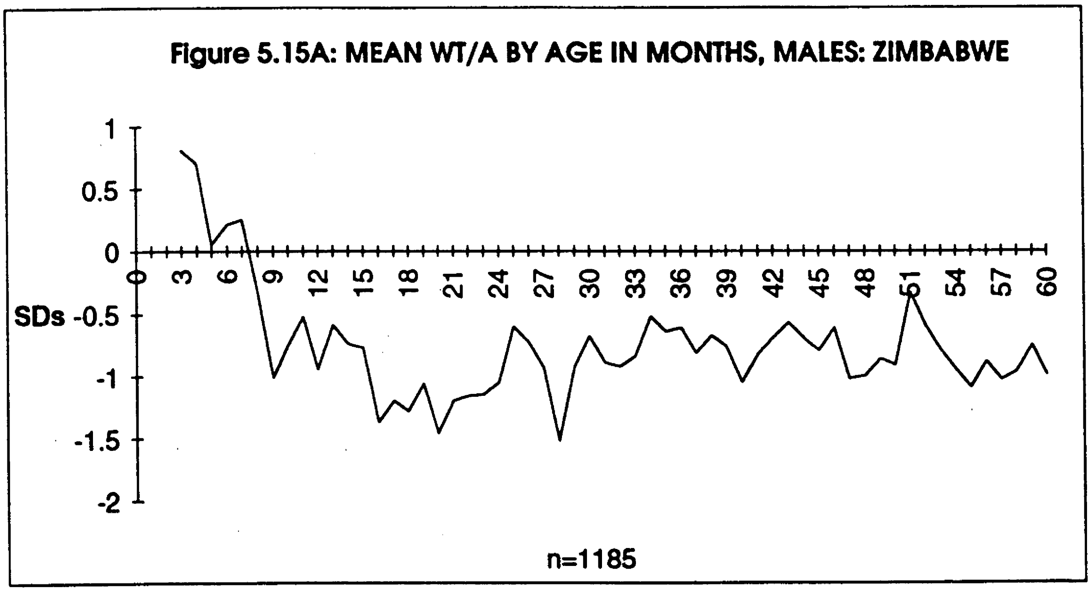
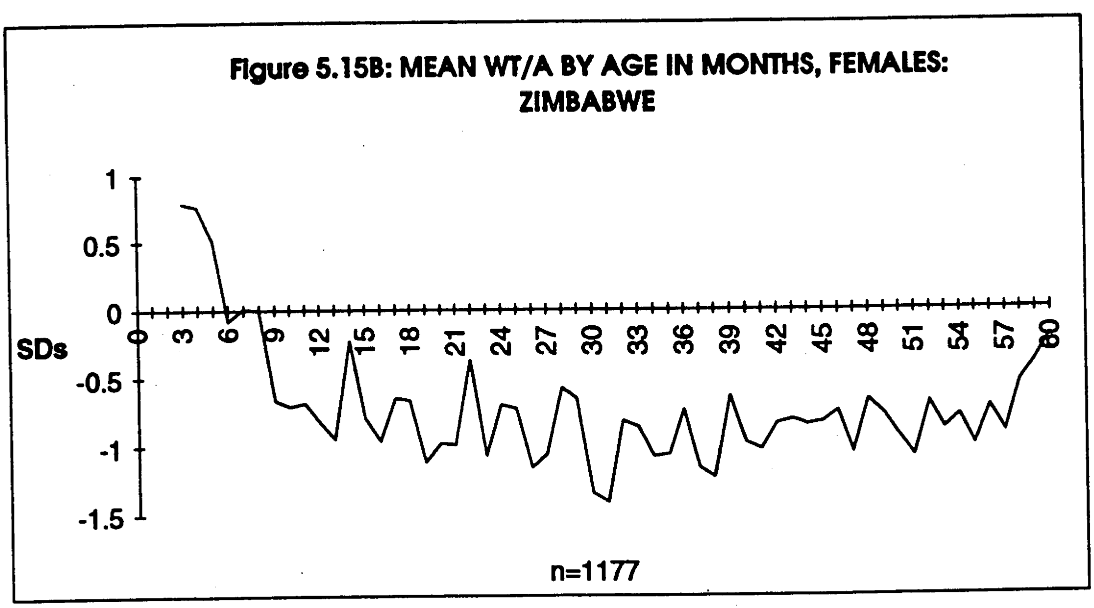


Figure 5.14B: MEAN HT/A BY AGE IN MONTHS, FEMALES: ZIMBABWE



SOURCE: As for Table 4.6.





SOURCE: As for Table 4.6.

The deterioration up to age 30 months is consistent with the findings of Moy et al. (1991), who examined longitudinal weight and height data for a sample of children of Zimbabwean farm labourers on large-scale commercial farms, whom they describe as 'a deprived community....with high prevalence of ill health and poor nutritional status' (Moy et al., 1991: 276). They found that birthweights were only slightly lower than the NCHS reference population, and that, for the first three months of life, weight velocity exceeded that of the reference population, while height velocity was similar. After six months, however, growth slowed and the mean weight and height of both sexes drifted below the 50th centile, and was below the 3rd centile by age 30 months (Moy et al., 1991: 279).

ACC/SCN (1993: 45) reported a tendency for children in many developing countries to manifest this growth pattern. They described it as a period of 'active growth failure', mainly between ages six and 24 months. It can be attributed to poor nutrition and the synergy of nutrition and infection. Esquivel Rios (1981: 232) reported that a nutrition intervention programme in Bahia, Brazil, was generally unable to counteract the adverse effect of poor environment on growth of children under age 12 months.

This consistent, marked deterioration of Z-scores with age, in all three study populations, has important implications for the interpretation of growth patterns. In particular, it affects comparisons of the growth attainment of children of different ages. This will be considered at greater length in the analysis of sibling patterns in Chapter Seven.

Table 5.19 uses the Waterlow approach to the identification of severely impaired growth attainment, using the conventional cut-off point of -2 SDs in a cross-tabulation of Wt/A with Wt/Ht. It can be seen that, once again, Zimbabwean children are least disadvantaged, with only 0.6 per cent both stunted and wasted. Ugandan children are almost as well off, with a little over 1 per cent suffering both conditions, but 2.5 per cent of Burundais children are both stunted and wasted.

The table also shows that 71 per cent of Zimbabwean children are neither stunted nor wasted, as are 56 per cent of Ugandans and 49 per cent of Burundais. In all three countries the percentage is less for older than for younger children, with the lowest values for children aged 25-36 months. The pattern is similar for those who are stunted but not wasted, while wasted but not stunted is a rare condition in all three countries. Hence the patterns in Table 5.19 are plausible and consistent with patterns in earlier tables, with Burundais children generally worse off than Ugandan children, and

Table 5.19: HT/A BY WT/HT (WATERLOW TABLE) : BURUNDI, UGANDA AND ZIMBABWE
(per cent)

BURUNDI	3-11 mths	12-23 mths	24-35 mths	All singleton	Multiple
-2 SD Ht/A & Wt/Ht or less	1.1	4.8	2.0	2.5	8.1
-2 SD Ht/A or less & > - 2 SD Wt/Ht	32.5	43.2	60.2	45.3	59.7
> -2 Ht/A & -2 SD Wt/Ht or below	2.9	5.3	1.5	5.1	32.2
> -2 SD Ht/A & Wt/Ht	63.6	46.8	36.3	49.0	0.0
Number	(654)	(604)	(647)	(1906)	(14)

UGANDA	3-11 mths	12-23 mths	24-35 mths	36-47 mths	48-60mths	All singleton	Multiple
-2 SD Ht/A & Wt/Ht or less	0.1	3.2	0.8	0.3	1.2	1.1	8.1
-2 SD Ht/A or less & > - 2 SD Wt/Ht	21.7	49.2	51.3	51.3	48.6	42.6	64.5
> -2 Ht/A & -2 SD Wt/Ht or below	0.7	0.6	0.8	0.8	0.1	0.6	0.0
> -2 SD Ht/A & Wt/Ht	77.5	47.0	47.0	47.6	50.1	55.6	27.4
Number	(971)	(834)	(696)	(644)	(546)	(3691)	(40)

ZIMBABWE	3-11 mths	12-23 mths	24-35 mths	36-47 Mths	48-60mths	All singleton	Multiple
-2 SD Ht/A & Wt/Ht or less	0.0	1.1	0.2	0.4	0.8	0.6	0.0
-2 SD Ht/A or less & > - 2 SD Wt/Ht	17.7	33.5	35.1	34.0	21.3	27.9	47.8
> -2 Ht/A & -2 SD Wt/Ht or below	0.5	0.7	0.9	0.9	1.0	0.8	0.0
> -2 SD Ht/A & Wt/Ht	81.8	64.7	63.8	64.7	76.8	70.7	52.2
Number	(440)	(544)	(440)	(450)	(488)	(2362)	(46)

SOURCE: As for Tables 4.4, 4.5 and 4.6

Zimbabwean children generally better off than either Burundais or Ugandan children. Although, overall, the percentages of children who are both stunted and wasted are small, in each country they are highest for the age group 13-24 months, the age at which weaning normally occurs. It must be borne in mind that, at any given level, wasting tends to have more severe implications for survival than stunting or wasting. Hence there are likely to be fewer wasted children in any data set, because of censoring by higher rates of mortality for cases at the lower extreme.

5.3.6 Growth velocities

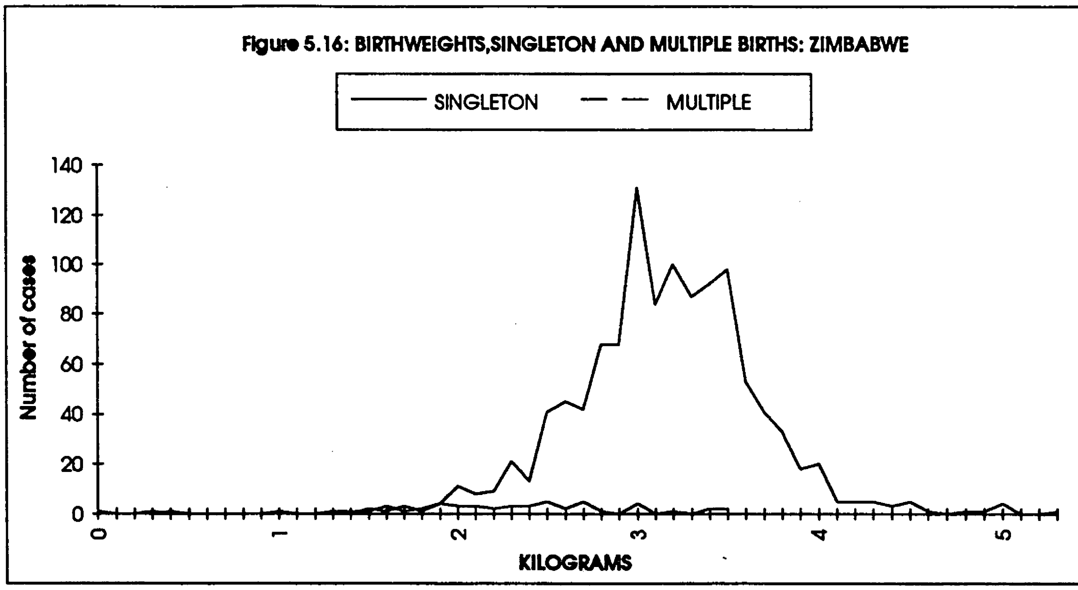
Normal children do not grow linearly, as discussed above. It is expected that the rate of increase in weight will be fastest for very young children and then gradually taper off. This can be seen in the familiar weight chart on the health card (see Figure 5.6). In addition, there may be minor perturbations in the rate of increase in weight, which have no obvious explanation but which are still within the normal range.

As noted in Chapter Four, birthweights were recorded for 1426 of the 2364 Zimbabwean measured children aged 3 to 60 months. Length at birth was not recorded. The characteristics of children with a birthweight are compared with the sample as a whole in Table 4.21. The main difference is that more birthweights are available for younger children than for older children, and more in urban than in rural areas. As a consequence of the rural-urban difference, there are more mothers with secondary education and fewer with no education amongst children with a birthweight.

Birthweights were recorded in grams, but there was heaping on numbers ending in a double 00 and 50, indicating that in many cases weights have been rounded to the nearest 50 or 100 grams. Since ZDHS weights were given only to the nearest 100 gms, birthweights also were rounded to the nearest 100 gms for this analysis. Figure 5.16 depicts the distribution of the birthweights recorded in the survey. It can be seen that the curve is close to normal, and the mean is close to mean birthweight in developed countries of from 3.2 to 3.3 kilograms (Ebrahim, 1983: 36; Gould, 1986: 394).

The average monthly increase in weight for each child was calculated using the formula

$$\frac{\text{(DHS weight) - Birthweight/100}}{\text{Age in Months}}$$



It should be noted that because all measurements have been taken to the nearest 100 gms the calculation of average monthly increase is subject to a small error, which is proportionally greater for lighter children than for heavier children.

Figure 5.17 plots mean monthly weight gain in grams for all children with birthweights, by month of age. The difference between single and multiple births was not noticeable on the plot, so these categories were not separated.

It must be noted that these data relate to mean monthly gain for the whole period between birth and date of measurement. As children were not measured each month, the data do not support the calculation of mean gain for each one month interval. Nonetheless, the decline in the mean rate as age increases reflects the slowing in growth rate each month. The curve is reasonably smooth, with a curve similar to the normal range on the Road to Health card (Figure 5.6). This suggests that birthweights recorded from health cards and measurements taken by DHS are plausible. The mean rate of gain levels off to between 200 and 300 grams per month for children aged 30 months and over.

Table 5.20 shows regression values for mean monthly weight gain with age for all births, multiple births, all singletons and singletons separately by sex. It can be seen that there is a consistent and significant negative relationship between rate of increase and age for all groups. In each case the mean rate decreases by around 10 grams per month. The r^2 values indicate that age explains 55 per cent of the variation in mean monthly weight gain for the sample as a whole, and as much as 64 per cent for multiple births. Factors contributing to the unexplained variation will be explored in Chapter Six.

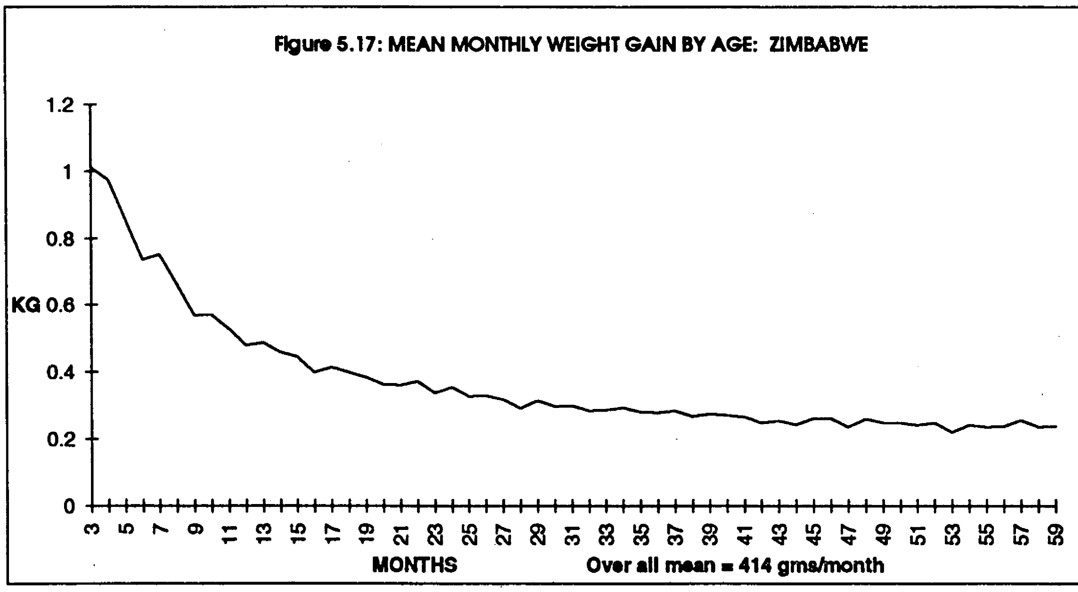


Table 5.20: REGRESSION OF MEAN MONTHLY WEIGHT GAIN WITH AGE: ZIMBABWE
(grams per month)

	gms Constant	gms b1.AGE	Adj r2	gms S.E.	Signif. F	Number
All Births	690	-10.30	0.55	149	p=<0.001	(1178)
Singletons	690	-10.40	0.55	151	p=<0.001	(1130)
Multiple births	696	-9.67	0.64	122	p=<0.001	(48)
Males	737	-11.37	0.58	157	p=<0.001	(590)
Females	647	-9.38	0.54	137	p=<0.001	(588)

5.5 DISCUSSION

This chapter has explored the nature of the height and weight data in the DHS data sets for Burundi, Uganda and Zimbabwe. The overall plausibility of the patterns depicted suggests that the measurements collected are of reasonable quality.

In keeping with the economic patterns described in Chapter Three, Zimbabwean children appear generally better off than those in Uganda and Burundi. This could also be because some children up to age five in the Burundais and Ugandan samples could have experienced deprivation caused by civil disruption, but this is unlikely for Zimbabwean children. There is less difference between children in Uganda and Burundi, but Burundais children are generally worse off than Ugandans. Of the three countries, Burundi exhibits most inconsistency, with irregularities in the distribution curves and lower proportions of variation explained by age. This could be due in part to the tendency for one ethnic group, the Tutsi, to be consistently advantaged in socio-economic status compared to the Hutu.

One of the most important findings in this chapter is the trend in growth attainment relative to the reference median, as depicted in Figures 5.10 to 5.15. It is apparent that, although birthweights and lengths are close to normal, there is a consistent, marked deterioration with age, in all three countries. This strongly suggests that differences between the three samples and the reference population are primarily due to socio-economic and environmental factors, rather than to ethnic or regional differences in growth patterns.

The policy implications of this finding are considerable. First, since a large proportion of the children in these countries become increasingly malnourished as their age increases, more attention needs to be given to child nutrition. Second, it suggests that the reference population is, in fact, an appropriate standard for the three countries. If so, to suggest that there are fundamental ethnic differences in growth patterns which require the use of a different, country-specific standard, may be no more than a way of ignoring the real issue of malnutrition.

This chapter has also shown the feasibility of treating growth attainment variables as continuous, rather than using cut-off points for population level analysis. Although cut-off points are a convenient method of grouping the population for particular purposes, it is apparent that continuous data should be used whenever grouping is not essential.

The regression analysis in this chapter has shown that much of the variation in height and weight can be explained by age, but a proportion of the variation must be attributed to other factors. This residual will be the subject of the analysis in Chapter Six.

CHAPTER SIX: SOCIO-ECONOMIC, DEMOGRAPHIC, ENVIRONMENTAL AND CHILD-CARE CORRELATES OF GROWTH ATTAINMENT

6.1 INTRODUCTION

The exploratory analysis in Chapter Five focused on stunting, underweight and wasting, defined as 2 SD or more below the reference value. It showed that high proportions of children in Burundi, Uganda and Zimbabwe were stunted. On the other hand, only around half as many children were underweight, and very few were wasted. In all three countries the patterns for multiple births were erratic.

The analysis in this chapter focuses on the factors most strongly associated with poor growth attainment. That is, an approach similar to that in Chapter Four is used to determine the characteristics of those children who are still in the 'alive' box in the causal model in Figure 1.4, but have poor growth attainment. The objective is to identify similarities and differences between surviving and dead children.

Only stunting and underweight amongst singleton births will be considered. Wasting is excluded from this analysis for two reasons. First, as shown in Figure 5.9, in all three countries the distribution of Wt/Ht was close to that of the reference population. Only 5.7 per cent of Burundais children were 2 SD or more below the reference value, and less than 2 per cent in both Uganda and Zimbabwe. This is insufficient for a statistically significant analysis of wasting. Moreover, it would not be meaningful to focus on the analysis of cases who are only a little below the reference value for Wt/Ht, for example, around -1 SD, since this does not have the same implications for health and survival.

The second reason is that wasting is a high-risk physical condition compared with stunting and underweight, and more likely to indicate growth faltering. The group of wasted children is therefore highly likely to be censored by deaths of the most severely affected children. A meaningful analysis of the correlates of wasting would require growth attainment data for both surviving and dead children. Such data were not available for the present analysis.

As in Chapter Four, the determinants considered are drawn from the four groups of socio-economic factors, demographic, environmental and child-care factors. However, as discussed earlier, these groupings have been selected for practical purposes only and are not intended to signify rigid boundaries. The following analysis demonstrates that interactions between variables in different groups are common.

It was noted in Chapter One that DHS-I data sets include only limited data on feeding patterns and morbidity, and no data on genetic and psychological factors and exercise. Because of this omission it is not possible to determine the relative importance of socio-economic, demographic, environmental and child-care factors as determinants of growth. This analysis is therefore confined to exploring their association with growth attainment, as measured by height and weight, and the interactions between them.

Two SDs below the reference value is used as a convenient division for classifying cases in the preliminary bi-variate analysis, since grouping of data is essential for cross-tabulations. This cut-off point also is used in a multi-variate, logistic regression analysis, to determine the odds of children with various characteristics being stunted or underweight. The third approach treats Ht/A and Wt/A as continuous dependent variables an OLS regression models, using the same independent variables as in the logistic regression. This allows comparison of the results, and also of the advantages and disadvantages of the two multi-variate approaches.

6.2 ANALYSIS OF DATA: BI-VARIATE

This section uses simple cross-tabulation to explore the association of stunting and underweight with the socio-economic, demographic, environmental and child-care variables depicted in Figure 1.4. For practical reasons it was necessary to select variables for inclusion in the analysis from many available in the data sets, while some important information, such as household income, was not available. As discussed in Chapter Three, variables relating to house construction materials and ownership of household goods are not considered to be good proxies for income in these data sets.

Where necessary, variables were recoded, as in Chapter Four, to eliminate categories with too few cases to produce meaningful results. As before, *reads with difficulty* and *cannot read* were combined in the variables describing mother's and husband's literacy.

Tables 6.1, 6.2 and 6.3 show that, in all three countries, most of the selected socio-economic variables have a highly significant relationship with stunting. The exception in

Table 6.1: SOCIO-ECONOMIC CHARACTERISTICS AND PERCENTAGE 2SD OR MORE BELOW THE REFERENCE MEDIAN HT/A AND WT/A, SINGLETONS: BURUNDI

	HT/A	Signif.(1)	WT/A	Signif.(1)	n
Mother's education					
None	48.8		39.0		1530
Primary	47.2		35.6		326
Secondary +	24.6		20.0		50
	Cramer's V=	0.08 p=<0.01	Cramer's V=	0.07 p=<0.05	
Mother's literacy					
Cannot Read	49.2		39.7		1629
Reads	40.1		28.1		276
	Cramer's V=	0.06 p=<0.01	Cramer's V=	0.08 p=<0.001	
Mother works					
No	48.4		38.6		1828
Yes	36.4		22.6		77
	Cramer's V=	0.05 p=<0.05	Cramer's V=	0.06 p=<0.01	
Husband's education					
None	48.8		40.2		1028
Primary	49.5		36.5		610
Secondary +	27.7		20.7		89
	Cramer's V=	0.09 p=<0.001	Cramer's V=	0.09 p=<0.001	
Husband's literacy					
Reads	46.6		33.5		1055
Cannot read	48.8		41.0		761
	Cramer's V=	0.02 n.s.	Cramer's V=	0.75 p=<0.01	
Husband's occupation					
Agricultural	49.3		39.1		1514
Prof/tech/cler.	21.9		18.0		46
Sales	38.5		32.2		77
Manufacturing	44.9		34.6		167
Domestic	57.9		47.9		28
Services	33.6		28.3		26
None	70.2		56.7		9
	Cramer's V=	0.11 p=<0.01	Cramer's V=	0.09 p=<0.01	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.4.

Table 6.2: SOCIO-ECONOMIC CHARACTERISTICS AND PERCENTAGE 2SD OR MORE BELOW THE REFERENCE MEDIAN HT/A AND WT/A SINGLETONS: UGANDA

	HT/A	Signif.(1)	WT/A	Signif.(1)	n
Religion					
Catholic	42.3		21.3		1620
Protestant	46.2		23.7		1532
Muslim	40.7		24.9		12
SDA, other	42.8		19.7		2
	Cramer's V = 0.04	n.s.	Cramer's V = 0.03	n.s.	
Ethnicity					
Alur	44.1		23.4		61
Ateso	37.2		19.0		60
Karimojong	48.3		19.3		17
Lugbara	40.7		30.4		191
Buganda	36.1		19.9		674
Mugushu	40.9		18.5		172
Mukiga	55.0		24.9		445
Mukonjo	51.2		28.4		98
Munyankole	53.3		25.6		471
Munyoro	35.6		18.1		160
Musoga	38.9		17.7		474
Mutoro	41.7		20.9		178
Samia	38.8		16.6		76
Other	44.8		26.7		613
	Cramer's V= 0.14	p=<0.001	Cramer's V= 0.09	p=<0.01	
Mother's education					
None	47.4		26.1		1548
Primary	43.9		21.6		1854
Secondary +	23.3		11.8		288
	Cramer's V= 0.12	p=<0.001	Cramer's V= 0.09	p=<0.001	
Mother's literacy					
Cannot read	46.9		26.0		2348
Reads	38.4		17.2		1327
	Cramer's V= 0.08	p=<0.001	Cramer's V= 0.10	p=<0.001	
Mother working					
No	44.7		23.1		3377
Yes	33.3		19.2		302
	Cramer's V= 0.06	p=<0.001	Cramer's V= 0.03	n.s.	
Husband's education					
None	49.6		28.3		606
Primary	45.3		23.4		2174
Secondary+	35.9		17.7		748
	Cramer's V= 0.09	p=<0.001	Cramer's V= 0.08	p=<0.001	
Husband's literacy					
Reads	42.4		21.2		2565
Cannot read	48.2		27.6		977
	Cramer's V= 0.05	p=<0.01	Cramer's V= 0.07	p=<0.001	
Husband's occupation					
None	63.7		30.0		22
Student	61.1		19.3		17
Government	37.1		18.4		334
Retail	42.4		22.0		1001
Manufacturing	33.8		16.6		102
Agriculture	46.1		24.5		2076
	Cramer's V= 0.08	p=<0.001	Cramer's V= 0.05	n.s.	
Number of other wives					
0	44.2		23.6		2164
1	47.7		24.4		646
2	41.6		19.1		266
3+	30.3		17.2		118
	Cramer's V= 0.06	p=< 0.01	Cramer's V= 0.04	n.s.	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.5.

Table 6.3: SOCIO-ECONOMIC CHARACTERISTICS AND PERCENTAGE 2SD OR MORE BELOW THE REFERENCE MEDIAN HT/A AND WT/A SINGLETONS: ZIMBABWE

	HT/A	Signif.(1)	WT/A	Signif.(1)	n
Language					
Shona	28.8		12.0		1913
Ndebele	25.6		7.1		394
Other	38.2		20.0		55
	Cramer's V =	0.04 n.s.	Cramer's V =	0.07 p=<0.01	
Religion					
Christian	25.4		10.1		1478
Non-Christian	33.6		13.3		882
	Cramer's V =	0.10 p=<0.001	Cramer's V =	0.05 p=<0.05	
Mother's education					
None	36.2		18.8		436
Primary	29.5		10.6		1527
Secondary +	15.8		6.0		399
	Cramer's V =	0.14 p=<0.001	Cramer's V =	0.12 p=<0.001	
Mother's literacy					
Reads	25.8		9.4		1807
Cannot read	36.9		17.8		555
	Cramer's V =	0.10 p=<0.001	Cramer's V =	0.11 p=<0.001	
Mother works					
No	30.6		12.2		1905
Yes	19.5		7.7		457
	Cramer's V =	0.10 p=<0.001	Cramer's V =	0.06 p=<0.01	
Mother's occupation					
Professional	7.2		5.8		69
Clerical	5.3		5.3		19
Sales, service	24.2		10.8		120
Housework	25.0		0.0		16
Manufacturing	20.3		7.3		232
Agriculture	32.6		12.0		368
	Cramer's V =	0.19 p=<0.001	Cramer's V =	0.09 n.s.	
Mother's weekly income					
0-20	27.7		8.2		256
21-40	24.3		10.8		111
41-100	14.9		10.6		94
101+	10.8		8.4		83
	Cramer's V =	0.16 p=<0.01	Cramer's V =	0.04 n.s.	
Husband's location					
At home	28.3		11.4		1743
Away	28.9		11.3		619
	Cramer's V =	0.01 n.s.	Cramer's V =	0.00 n.s.	
Husband's education					
None	39.9		18.9		243
Primary	30.1		11.7		1290
Secondary+	19.8		7.2		615
	Cramer's V =	0.14 p=<0.001	Cramer's V =	0.11 p=<0.001	
Husband's literacy					
Reads	27.3		10.3		2104
Cannot read	44.0		22.0		182
	Cramer's V =	0.10 p=<0.001	Cramer's V =	0.10 p=<0.001	
Husband's occupation					
Manufacturing	26.5		10.2		822
Agricultural	35.3		16.9		632
Professional	24.2		9.4		149
Clerical	18.2		9.1		154
Sales	27.5		8.0		338
Domestic	33.3		5.4		111
None	42.6		14.9		47
	Cramer's V =	0.12 p=<0.001	Cramer's V =	0.12 p=<0.001	
Childcarer					
Other children	23.5		7.1		85
Adult relative	24.8		9.1		165
Neighbour	15.4		7.7		13
Domestic help	11.5		6.4		78
Nursery	24.2		6.1		33
	Cramer's V =	0.13 n.s.	Cramer's V =	0.05 n.s.	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.6.

Burundi is *husband's literacy*, but this variable is highly significant in Uganda and Zimbabwe, while *husband's education* is highly significant in all countries.

Fewer socio-economic variables are available for Burundi than for Uganda and Zimbabwe, and the Cramer's V statistic indicates that relationships are generally weaker than in Uganda and Zimbabwe. Particularly important is the omission of ethnicity, religion and tribal affiliation for Burundi. Although, as discussed in Chapter Five, it is now generally agreed that children of all ethnicities have the same growth potential at young ages, these variables would be expected to be strongly associated with growth attainment in Burundi, because they reflect economic and social differences between the Tutsi and Hutu. Most Burundais mothers and husbands with secondary education, and most husbands with a professional or clerical occupation, belong to the Tutsi ethnic group.

Religion is the only selected socio-economic variable for Uganda that is not statistically significant at the 95 per cent level, or higher, in relation to stunting. Most other variables for this country show the expected relationship with both stunting and underweight. An interesting feature is the very high prevalence of stunting in the category *student* for *husband's occupation*, which is comparable to the level among those with no occupation. It is notable that stunting and underweight are less common in households with more wives. As discussed in Chapters Two and Four, such households may provide better care and/or are wealthier than households with few wives. Desai (1991: 1004), who found no significant evidence of stunting in polygamous households in West Africa, considered that number of wives was possibly a proxy for income, since males with higher incomes are more likely to be able to afford to be in a polygamous union.

Uganda shows considerable variation in both stunting and underweight by ethnicity. As ethnic groups tend to be associated with particular regions, the differences may be due to a combination of environmental conditions, socio-economic characteristics, control over resources, and dietary patterns, as discussed in Chapter Three.

The ZDHS included questions about the whereabouts of the respondent's husband, while respondents who themselves were working were asked who cared for their children. Table 6.3 shows that, other than language, these are the only factors not significantly related to stunting. *Mother's occupation* and stunting show the strongest relationship in any of the three tables, with a Cramer's V of 0.19. The next strongest relationship is that of *mother's income* and stunting. However, only about 35 per cent of all singleton children aged 5 years and under had a working mother. The Cramer's V statistics for underweight are generally lower than those for stunting, except in the case of *mother's* and *husband's literacy*. *Mother's* and *husband's education* have Cramer's V values of .10 or more for both stunting and underweight.

Significant relationships with Ht/A and Wt/A are less common amongst the demographic variables in Tables 6.4, 6.5 and 6.6. As expected from the analysis in Chapter Five, *child's age* is highly significant and has a strong relationship in each country. However, *mother's age* is significant only in Uganda. *Number of births in the past five years* also is significant in Burundi and Uganda. Surprisingly, the prevalence of stunting and wasting is less amongst children whose mothers had more births. *Sex of child* is significant only for stunting in Uganda, and birth order only for stunting in Zimbabwe.

The length of the preceding birth interval is highly significant in all three countries. In Uganda and Zimbabwe both stunting and underweight are most prevalent amongst children with a preceding birth interval of less than 24 months. This clearly demonstrates the adverse effects of having a competing sibling close in age. Stunting and underweight are most prevalent in Burundi, where more than 50 per cent of children with a short preceding birth interval are stunted, and almost 44 per cent are underweight. However, a slightly higher percentage of first-born children are stunted in this country.

Rather surprisingly, in Burundi and Uganda the pattern for *succeeding birth interval* is the reverse of that for *preceding birth interval*. In these countries the prevalence of stunting and underweight is significantly higher where birth intervals are longest. This also is true for Wt/A in Zimbabwe, but the prevalence of stunting tends to decline with longer succeeding intervals.

These patterns can be attributed to the effect of *child's age* on growth attainment, as shown in Figures 5.10 to 5.15. In Burundi and Uganda Z-scores gradually deteriorate and then remain low from ages 1-5 years, whereas those of Zimbabwean children tend to improve slightly at older ages. Since children with a succeeding birth interval of 36 months or more must themselves be at least three years old, they have a higher risk of being stunted. It is also possible that in Burundi and Uganda, where fertility is high,

Table 6.4: DEMOGRAPHIC CHARACTERISTICS AND PERCENTAGE 2SD OR MORE BELOW THE REFERENCE MEDIAN HT/A AND WT/A SINGLETONS: BURUNDI

	HT/A	Signif.(1)		WT/A	Signif.(1)		n
Mother's age (years)							
15-19	25.4			22.4			16
20-24	48.4			36.9			354
25-29	49.0			37.5			596
30-34	45.8			36.5			465
35-39	49.1			42.1			300
40-44	48.1			39.8			119
45-49	48.9			40.4			54
	Cramer's V =	0.05	n.s.	Cramer's V =	0.05	n.s.	
Births in last 5 years							
1	51.3			41.5			655
2	46.6			35.7			1027
3+	43.8			38.1			223
	Cramer's V =	0.05	n.s.	Cramer's V =	0.06	n.s.	
Child's age (months)							
3-5	18.7			5.7			230
6-11	41.7			39.3			424
12-17	44.0			41.4			317
18-23	52.4			43.0			287
24-29	59.7			47.7			349
30-36	65.2			41.1			298
	Cramer's V =	0.28	p=<0.001	Cramer's V =	0.25	p=<0.001	
Sex of child							
Male	48.1			37.3			967
Female	47.6			38.7			939
	Cramer's V =	0.00	n.s.	Cramer's V =	0.01	n.s.	
Birth order							
1-5	48.9			37.4			1426
6-10	45.4			39.6			457
11+	36.7			41.8			23
	Cramer's V =	0.04	n.s.	Cramer's V =	0.02	n.s.	
Preceding birth interval							
First Born							
< 24 months							
24-35 months	50.7			43.8			277
36 months +	45.8			35.7			1315
	Cramer's V =	0.04	n.s.	Cramer's V =	0.06	p=<0.05	
Succeeding birth interval							
<24 months	45.0			37.5			102
24-35 months	67.9			42.9			159
	Cramer's V =	0.23	p=<0.001	Cramer's V =	0.05	n.s.	
Dead sibling							
No	49.5			37.0			1159
Yes	45.3			39.5			747
	Cramer's V =	0.04	n.s.	Cramer's V =	0.02	n.s.	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.4.

Table 6.5: DEMOGRAPHIC CHARACTERISTICS AND PERCENTAGE 2SD OR MORE BELOW THE REFERENCE MEDIAN HT/A AND WT/A SINGLETONS: UGANDA

	HT/A		Signif.(1)	WT/A		Signif.(1)	n
Mother's age							
15-19	35.6			18.6			320
20-24	45.7			24.0			931
25-29	46.0			22.8			1035
30-34	44.3			26.4			675
35-39	39.9			19.2			468
40-44	44.1			20.0			203
45-49	41.4			20.0			59
	Cramer's V=	0.06	p=<0.05	Cramer's V=	0.03	n.s.	
Births in last 5 years							
1	43.2			23.3			950
2	46.4			23.4			1958
3+	38.0			20.4			777
	Cramer's V=	0.07	p=<0.001	Cramer's V=	0.03	n.s.	
Child's age in months							
3-5	10.0			2.9			486
6-11	33.6			25.1			485
12-17	47.5			32.2			461
18-23	58.3			29			373
24-29	50.9			28			357
30-35	53.5			25.9			339
36-47	51.6			21.5			644
48-60	49.8			22			546
	Cramer's V=	0.30	p=<0.001	Cramer's V=	0.20	p=<0.001	
Sex of child							
Male	46.7			22.5			1821
Female	40.9			22.9			1870
	Cramer's V=	0.06	p=<0.001	Cramer's V=	0.00	n.s.	
Birth order							
1-5	44.3			22.9			2510
6-10	42.7			22.4			1084
11+	40.5			22.6			97
	Cramer's V=	0.02	n.s.	Cramer's V=	0.00	n.s.	
Preceding birth interval							
First Born	43.3			22.9			611
< 24 months	48.3			26.6			837
24-35 months	45.1			22.3			1336
36 months +	38.0			19.7			906
	Cramer's V=	0.07	p=<0.001	Cramer's V=	0.06	p=<0.01	
Succeeding birth interval							
< 24 months	39.6			16.8			448
24-35 months	52.2			21.9			723
36 months +	64.1			35.5			184
	Cramer's V=	0.16	p=<0.001	Cramer's V=	0.14	p=<0.001	
Dead sibling							
No	43.9			22.1			2077
Yes	43.6			23.6			1614
	Cramer's V=	0.00	n.s.	Cramer's V=	0.02	n.s.	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.5

Table 6.6: DEMOGRAPHIC CHARACTERISTICS AND PERCENTAGE 2SD OR MORE BELOW THE REFERENCE MEDIAN HT/A AND WT/A, SINGLETONS: ZIMBABWE

	HT/A	Signif.(1)	WT/A	Signif.(1)	n
Mother's age					
15-19	28.7		11.5		122
20-24	24.9		9.3		550
25-29	29.3		12.0		627
30-34	28.7		10.9		515
35-39	33.0		14.1		333
40-44	22.0		11.3		150
45-49	38.5		12.3		65
Cramer's V=	0.00	n.s.	Cramer's V= 0.05	n.s.	
Births in last 5 years					
1	27.3		11.5		933
2	28.8		11.3		1219
3 +	32.7		11.4		202
Cramer's V=	0.05	n.s.	Cramer's V= 0.02	n.s.	
Child's age in months					
3-5	9.6		0.6		177
6-11	22.3		9.6		251
12-17	29.9		14.6		281
18-23	39.4		15.4		254
24-29	38.0		19.0		274
30-35	30.6		10.8		232
36-47	33.2		11.2		428
48-60	21.1		8.2		465
Cramer's V=	0.18	p=<0.001	Cramer's V= 0.14	p=<0.001	
Sex of child					
Male	29.8		11.2		1185
Female	27.1		11.5		1177
Cramer's V=	0.03	n.s.	Cramer's V= 0.00	n.s.	
Birth order					
1-5	27.0		10.2		1762
6-10	32.4		14.5		564
11+	38.9		16.7		36
Cramer's V=	0.06	p=<0.05	Cramer's V= 0.06	p=<0.05	
Preceding birth interval					
First Born	25.3		9.3		451
< 24 months	35.8		15.1		358
24-35 months	30.7		12.6		823
36 months +	24.2		9.3		730
Cramer's V=	0.09	p=<0.001	0.07	p=<0.05	
Succeeding birth interval			Cramer's V=		
< 24 months	30.6		8.8		170
24-35 months	29.6		10.3		399
36 months +	24.9		11.8		169
Cramer's V=	0.05	n.s.	Cramer's V= 0.03	n.s.	
Dead sibling					
No	26.9		10.2		1741
Yes	32.7		14.7		621
Cramer's V=	0.06	p=<0.01	Cramer's V= 0.06	p=<0.01	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.6.

mothers who did not have a birth within three years of the survey could have been experiencing hardship due to economic and social disruption. As a consequence of this age pattern, *succeeding birth interval* cannot be considered as a reflection of the effect of sibling competition.

Dead sibling is significant in Zimbabwe, but not in Uganda and Burundi, where mortality rates are higher. *Sex of child* is significant only for Ht/A in Uganda, with fewer female children being stunted.

The Cramer's V statistics indicate that, except for *child's age* (in all three countries) and *succeeding birth interval* (in Uganda), relationships between demographic variables and Ht/A and Wt/A tend to be weak. The weak relationship between sex and growth attainment lends support to the view that, unlike some Asian cultures, Africans tend not to discriminate against girls when feeding children (see, for example, Ewbank, Henin and Kekovole, 1986; Sommerfelt, 1991; Gbenyon and Locoh, 1992).

Tables 6.7, 6.8 and 6.9 indicate that most environmental factors have a highly significant association with both Ht/A and Wt/A in Uganda and Zimbabwe, and a significant association in Burundi. *Region, place of residence, source of drinking water* and *type of toilet facility* are particularly important in each country. It is interesting that the Blair toilet, a closed, ventilated unit developed in Zimbabwe, does not rate much better than a pit latrine in its association with stunting and underweight in that country. This points to the indirect nature of many relationships between variables. In this instance, *type of toilet facility* appears to function as a proxy for environmental conditions, and thus has an indirect association with growth attainment. The Blair toilet is usually installed where piped water is unavailable. Although the toilet itself may help to prevent the spread of diarrhoeal disease, households which use Blair toilets are likely to rely on surface drinking water, which carries a high risk of contamination. They also are likely to have insufficient clean water for regular hand washing.

Some 42 per cent of Zimbabwe children lived in households reporting no access to toilet facilities, compared with only around 4 per cent in Burundi and 16 per cent in Uganda. Although surprising, in view of the generally better economic conditions in Zimbabwe, this is consistent with UNICEF's (1985: 98) estimate that in 1981 between 74 and 85 per cent of a sample of rural families had no toilet facilities and were 'using the bush as a

Table 6.8: ENVIRONMENTAL CHARACTERISTICS AND PERCENTAGE 2SD OR MORE BELOW THE REFERENCE MEDIAN HT/A AND WT/A,SINGLETONS: UGANDA

	HT/A	Signif.(1)	WT/A	Signif.(1)	n
Region					
West Nile	43.4		32.0		200
East	43.6		20.2		1000
Central	34.6		20.2		890
West	45.8		21.8		233
South West	53.8		26.9		1190
Kampala	21.5		12.3		178
Cramer's V=	0.18	p=<0.001	Cramer's V= 0.10	p=<0.001	
Place of residence					
Urban	24.9		12.3		330
Rural	45.6		23.3		3361
Cramer's V=	0.12	p=<0.001	Cramer's V= 0.08	p=<0.001	
Electricity to house					
No	45.2		23.4		3474
Yes	20.4		11.4		217
Cramer's V=	0.12	p=<0.001	Cramer's V= 0.07	p=<0.001	
Has refrigerator					
No	44.1		22.9		3659
Yes	5.5		3.6		31
Cramer's V=	0.07	p=<0.001	Cramer's V= 0.04	p=<0.05	
Drinking water source					
Piped to res.	7.7		7.7		29
Outside tap	29.2		17.4		219
Well or bore	42.2		21.8		1795
Surface,other	48.0		24.7		1648
Cramer's V=	0.11	p=<0.001	Cramer's V= 0.06	p=<0.01	
Distance to water source					
< 500m	43.5		22.1		1255
.5-1 km	44.7		25.3		1120
1 - 1.5 km	43.0		20.1		798
1.5 - 4.5 km	43.4		23.0		481
4.5 km +	46.8		18.9		36
Cramer's V=	0.01	n.s.	Cramer's V= 0.05	n.s.	
Type of toilet facility					
None	47.8		24.8		624
Flush	13.6		10.7		97
Latrine, pit	43.9		22.7		2970
Cramer's V=	0.10	p=<0.001	Cramer's V= 0.05	p=<0.01	
Soap in house					
No	46.3		23.9		538
Yes	43.3		22.5		3151
Cramer's V=	0.02	n.s.	Cramer's V= 0.01	n.s.	
No. in household					
1-6	46.9		25.1		1853
7-10	41.1		21.1		1398
10 +	39.1		17.9		439
Cramer's V=	0.06	p=<0.001	Cramer's V= 0.06	p=<0.001	
Births in past 5 years					
1	42.9		23.1		955
2	46.4		23.4		1958
3+	38.0		20.4		777
Cramer's V=	0.07	p=<0.001	Cramer's V= 0.03	n.s.	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.5

Table 6.9: ENVIRONMENTAL CHARACTERISTICS AND PERCENTAGE 2SD OR MORE BELOW THE REFERENCE MEDIAN HT/A AND WT/A SINGLETONS: ZIMBABWE

	HT/A	Signif.(1)		WT/A	Signif.(1)		n
Region							
Manicaland	31.9			10.7			345
Mashonaland E.	34.8			12.8			328
Mashonaland W.	25.4			14.1			291
Mashonaland C.	25.1			14.3			175
Matableleland N.	37.0			11.8			119
Matabeleland S.	30.3			10.1			178
Midlands	29.8			16.5			339
Masvingo	29.8			8.2			305
Harare/Chitungwiza	8.4			1.5			131
Bulawayo	19.2			5.3			151
	Cramer's V=	0.14	p=<0.001	Cramer's V=	0.12	p=<0.001	
Place of residence							
Rural	32.9			13.3			1811
Urban	14.0			5.1			551
	Cramer's V=	0.18	p=<0.001	Cramer's V=	0.11	p=<0.001	
Strata (type of land holding)							
Communal	32.4			12.9			1353
Large commercial	32.6			13.5			362
Small commercial	14.0			5.1			551
Resettlement	45.8			20.8			72
Urban	20.8			4.2			24
	Cramer's V=	0.19	p=<0.001	Cramer's V=	0.12	p=<0.001	
Drinking water source							
Well	31.2			13.4			1150
Piped to house	14.3			5.0			503
Outside tap	30.1			12.6			390
Surface,other	38.0			12.2			303
	Cramer's V=	0.17	p=<0.001	Cramer's V=	0.11	p=<0.001	
Distance to drinking water							
On premises	16.9			6.0			718
< 30 m	31.8			12.1			255
31-100 m	33.6			15.3			268
101-1 km	34.2			13.8			894
> 1 kilometre	32.6			13.2			227
	Cramer's V=	0.17	p=<0.001	Cramer's V=	0.11	p=<0.001	
Electricity							
No	32.3			13.2			1836
Yes	15.0			4.9			526
	Cramer's V=	0.16	p=<0.001	Cramer's V=	0.11	p=<0.001	
Has refrigerator							
No	30.2			12.1			2143
Yes	11.0			4.1			218
	Cramer's V=	0.12	p=<0.001	Cramer's V=	0.07	p=<0.001	
Type of Toilet facility							
None	35.4			14.8			1000
Flush	14.7			4.6			611
Blair toilet	27.3			10.6			417
Pit latrine	33.7			14.2			332
	Cramer's V=	0.19	p=<0.001	Cramer's V=	0.13	p=<0.001	
Toilet Users							
One household	22.0			8.4			1001
Neighbours	26.8			8.9			291
Communal	26.5			11.8			68
	Cramer's V=	0.05	n.s.	Cramer's V=	0.03	n.s.	
No. in household							
1-6	28.7			11.2			1016
7-10	27.9			12.5			1002
11+	29.1			8.4			344
	Cramer's V=	0.01	n.s.	Cramer's V=	0.04	n.s.	
Children aged 5 and under							
1	25.3			10.7			665
2	27.2			10.5			1101
3+	34.4			13.6			596
	Cramer's V=	0.08	p=<0.001	Cramer's V=	0.04	n.s.	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.6.

Table 6.9: ENVIRONMENTAL CHARACTERISTICS AND PERCENTAGE 2SD OR MORE BELOW THE REFERENCE MEDIAN HT/A AND WT/A SINGLETONS: ZIMBABWE

	HT/A	Signif.(1)		WT/A	Signif.(1)		n
Region							
Manicaland	31.9			10.7			345
Mashonaland E.	34.8			12.8			328
Mashonaland W.	25.4			14.1			291
Mashonaland C.	25.1			14.3			175
Matableleland N.	37.0			11.8			119
Matabeleland S.	30.3			10.1			178
Midlands	29.8			16.5			339
Masvingo	29.8			8.2			305
Harare/Chitungwiza	8.4			1.5			131
Bulawayo	19.2			5.3			151
	Cramer's V=	0.14	p=<0.001	Cramer's V=	0.12	p=<0.001	
Place of residence							
Rural	32.9			13.3			1811
Urban	14.0			5.1			551
	Cramer's V=	0.18	p=<0.001	Cramer's V=	0.11	p=<0.001	
Strata (type of land holding)							
Communal	32.4			12.9			1353
Large commercial	32.6			13.5			362
Small commercial	14.0			5.1			551
Resettlement	45.8			20.8			72
Urban	20.8			4.2			24
	Cramer's V=	0.19	p=<0.001	Cramer's V=	0.12	p=<0.001	
Drinking water source							
Well	31.2			13.4			1150
Piped to house	14.3			5.0			503
Outside tap	30.1			12.6			390
Surface,other	38.0			12.2			303
	Cramer's V=	0.17	p=<0.001	Cramer's V=	0.11	p=<0.001	
Distance to drinking water							
On premises	16.9			6.0			718
< 30 m	31.8			12.1			255
31-100 m	33.6			15.3			268
101-1 km	34.2			13.8			894
> 1 kilometre	32.6			13.2			227
	Cramer's V=	0.17	p=<0.001	Cramer's V=	0.11	p=<0.001	
Electricity							
No	32.3			13.2			1836
Yes	15.0			4.9			526
	Cramer's V=	0.16	p=<0.001	Cramer's V=	0.11	p=<0.001	
Has refrigerator							
No	30.2			12.1			2143
Yes	11.0			4.1			218
	Cramer's V=	0.12	p=<0.001	Cramer's V=	0.07	p=<0.001	
Type of Toilet facility							
None	35.4			14.8			1000
Flush	14.7			4.6			611
Blair toilet	27.3			10.6			417
Pit latrine	33.7			14.2			332
	Cramer's V=	0.19	p=<0.001	Cramer's V=	0.13	p=<0.001	
Toilet Users							
One household	22.0			8.4			1001
Neighbours	26.8			8.9			291
Communal	26.5			11.8			68
	Cramer's V=	0.05	n.s.	Cramer's V=	0.03	n.s.	
No. in household							
1-6	28.7			11.2			1016
7-10	27.9			12.5			1002
11+	29.1			8.4			344
	Cramer's V=	0.01	n.s.	Cramer's V=	0.04	n.s.	
Children aged 5 and under							
1	25.3			10.7			665
2	27.2			10.5			1101
3+	34.4			13.6			596
	Cramer's V=	0.08	p=<0.001	Cramer's V=	0.04	n.s.	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.6.

toilet'. Similarly, FAO (1990: 13) reported that between 58 per cent and 82 per cent of Zimbabwe households had no toilet facilities whatsoever.

Owning a refrigerator is significant in all three countries, but *electricity* is significant only in Burundi and Uganda. This is probably because household electricity reaches urban areas and most commercial farms in Zimbabwe, but only wealthier families can afford a refrigerator. *Owning a refrigerator* is associated with a much lower prevalence of stunting in Burundi, although there are too few cases to be statistically significant. These two variables could act in various ways. On one hand they may reduce illness directly by preventing food contamination, but on the other hand they may be a proxy for higher socio-economic status, urban living and greater control over resources.

Distance to water source is highly significant in Burundi and Zimbabwe, but not in Uganda. As noted in Chapter Four, this variable was pre-coded in the Uganda data set, with the lowest category being *up to 1/4 mile*, whereas it was expressed in minutes in Burundi and metres in Zimbabwe. It is apparent that, in Burundi and Zimbabwe, the crucial distinction is between having water on the premises or not; so the broad category in Uganda conceals likely differences.

Number in household is significant only for Ht/A in Uganda, where larger households had a lower prevalence, possibly because they were located in rural areas with better access to food. *Number of children under age five* is significant only for Ht/A in Zimbabwe, with less stunting where there are fewer children. The pattern remained much the same when these variables were grouped in several different ways.

Place of residence is highly significant for both stunting and underweight in all three countries, as is *region* in Uganda and Zimbabwe. In the case of Uganda a probable cause of much of this regional variation is differences in diet. McCance and Rutishauser (1975: 90) observed that childhood malnutrition is more prevalent in southern regions, where cooking-bananas are the staple food. Plate Five depicts a rich variety of grains and pulses, from all over Uganda, on sale at the Kampala market. The dishes prepared from them, some of which are also shown in Plate Five, are palatable and nutritious. However, in regions where the local staple is cooking-banana, children whose parents lack the means to purchase grains may have inadequate diets. Cooking bananas are steamed to produce *matoki* (on blue dish at rear of table, Plate Five, lower panel) which is bulky and of relatively low food value, weight for weight, compared with millet cake

PLATE FIVE: Kampala food market and Ugandan food dishes (on second blue dish from front). Small children may be unable to consume enough *matoki* to obtain adequate nutrition.

The highest incidence of stunting, and second highest incidence of underweight, in South West Province is consistent with this hypothesis. Although region has year round rainfall, and is little affected by seasonality, the higher prevalence of malnutrition is an on-going phenomenon. On the other hand, staple foods are more nutritious in the drier areas of Uganda, but food availability tends to be more variable because of intermittent drought. For example, Gladwin (1989: 7) noted that the incidence of kwashiorkor amongst children under age five in Lira district, an area in the drier northern region which was not included in UDHS, was significantly greater in September than in April.

The lower significance of *region* in Burundi than in Uganda and Zimbabwe could be partially an artifact of the uneven distribution of cases. It must also be attributed to the composite character of the regional classification used in EDSB. For example, Imbo comprises urban Bujumbura and its associated townships as well as the fertile but malaria-prone agricultural lands on the shores of Lake Tanganyika. Similarly, the Central Plateau is a large region, ranging from the wetter foothills of the west to the drier plateaux of the east, and composed of various land types and differing agricultural capacities and population densities.

Strata (type of land holding), is available only for Zimbabwe, but features as highly significant. Although both low Ht/A and Wt/A are most prevalent in resettlement areas, the pattern is otherwise consistent with Loewenson's (1990: 64) report that malnutrition is highest amongst children in large-scale farming areas and communal areas. However, Thomas (1992) used ZDHS growth attainment data to refute Loewenson's (1986) claim that the health status of Zimbabwean children was poorest in the commercial farm areas in Zimbabwe.

While the matter of who is most disadvantaged may be debated, depending on the data and period referred to, the poor circumstances of Zimbabweans on commercial farms are generally recognised. For example, Moy et al. (1991) classified their sample of children on large-scale commercial farms as 'a deprived rural community'. An interesting finding of their study was that there was no evidence of seasonality in the growth of these children, since their families did not have access to gardens, and purchased commercial foodstuffs throughout the year (Moy et al., 1991: 280).

Region for Zimbabwe shows a highly significant relationship with both stunting and wasting. However, the pattern by region does not match the findings of some other studies. In Table 6.9 Matabeleland North has the highest incidence of stunting while Midlands has the highest incidence of underweight. FAO (1990: 10) also reported the highest incidence of stunting in 1988 was in Matabeleland North, but, in contrast, the World Bank (1991: 18) cited Ministry of Health National Survey findings that Masvingo had the highest case fatality rate for malnutrition in 1988, and the highest incidence of stunting in both 1985 and 1988. Matabeleland North also had the highest incidence of underweight in 1989 according to the World Bank (1991: 20-21). Ministry of Health data indicate that Mashonaland East had the least stunting in 1985 and 1988, excluding urban areas (World Bank, 1991: 20), yet Table 6.9 shows that, in the DHS sample, Mashonaland East had the second highest incidence of stunting. FAO (1990: 10) indicated that Mashonaland East had the third highest incidence of stunting after Matabeleland North and Manicaland. A consistent result in both ZDHS and Ministry of Health surveys is that, although urban areas are generally better off than the provinces, Bulawayo is considerably worse off than Harare / Chitungwiza.

One possible source of disparity is the use of different indicators. In this study stunting and underweight are defined as 2 SDs or more below the reference value, while Ministry of Health uses arm circumference and the proportion below the 3rd centile. Another possibility is that the results are affected by seasonality, or by variation within the population, since the differences in percentage points between provinces are generally not great, whichever data source is used. FAO (1990: 7) commented that seasonal patterns in nutrition are well documented in Zimbabwe, with malnutrition, diarrhoea and measles peaking between September and January when food is scarce. In fact the ZDHS fieldwork coincided exactly with this time, commencing on 15 September 1988 and finishing in late January 1989 (ZCSO & IRD, 1989: 10).

The Cramer's V values for environmental variables are all below 10 per cent in Burundi, generally higher in Uganda and highest in Zimbabwe. This is consistent with better economic conditions in Zimbabwe as a whole. The impact of an unfavourable environment is thus more easily distinguished than in Burundi and Uganda, where poverty is more uniform.

The association of child-care practices with stunting and underweight is shown in Tables 6.10, 6.11 and 6.12. It is noticeable that the association of all factors is generally highly significant in Zimbabwe, but less so in Burundi and Uganda. This is consistent with the generally higher utilization of health services in Zimbabwe. *Ante-natal care* and *owning a health card* are not significant in Burundi, although *ante-natal anti-tetanus immunization* is significant. All three of these variables are significantly related to Ht/A in Uganda, while *ante-natal care* and *immunization*, but not *owning a health card*, are related to Wt/A. *Ante-natal care* was coded as *yes* or *no* in Tables 6.10, 6.11 and 6.12, although in the raw data it is presented as *number of visits*. It is interesting to note that when it is treated as a continuous variable there is a significant positive relationship with stunting in each country. This is probably because frequent visits often reflect a high risk pregnancy, which is likely to result in a sickly child (Potts, Janowitz and Fortney, 1983).

The variable describing immunization coverage is an age-standardized variable calculated from the immunization records in the data sets. It indicates the proportion of immunizations for which the child was eligible that have actually been received. The recommended minimum immunization schedule, which is observed in all three countries, is one dose of BCG at birth, three doses each of DPT and polio vaccine at ages three, four and five months, and one dose of measles vaccine at nine months (Dick, 1985:8). Hence a three-month-old child who had received BCG, DPT1 and Polio1 is classified as fully immunized, whereas a twelve month old child who had received BCG, three DPTs and three polios, but not measles vaccine, is classified as having only partial immunization coverage.

The tables show that *immunization coverage* is not significantly related to Wt/A in any of the three countries, and is significantly related to Ht/A at the 95 per cent level only in Burundi. This probably reflects the nature of immunization campaigns in Africa, as discussed in McMurray and Nzima (1990). Where campaigns are implemented, they tend to reach evenly across all strata of society. The critical issue is whether the immunization campaign has extended to a region at all rather than differences in service utilization within a region.

However, *immunization timing* is highly significant for all three countries. It is well known that to be effective an immunization must be received at the correct time. If given too late the child may have already contracted the immunizable disease, while if

Table 6.10: CHILDCARE AND PERCENTAGE 2SD OR MORE BELOW REFERENCE MEDIAN HT/A AND WT/A, SINGLETONS: BURUNDI

	HT/A		Signif.(1)	WT/A		Signif.(1)	n
Ante-natal care							
No	49.6			41.6			332
Yes	47.5			37.2			1574
	Cramer's V=	0.02	n.s.	Cramer's V=	0.03	n.s.	
Ante-natal anti-tetanus							
No	52.3			40.9			661
Yes	45.3			36.5			1231
	Cramer's V=	0.07	p=<0.01	Cramer's V=	0.04	n.s.	
Health card							
No	45.2			36.0			516
Yes	48.9			38.7			1390
	Cramer's V=	0.03	n.s.	Cramer's V=	0.02	n.s.	
Immunization cover							
None	45.8			36.5			801
Partial	45.6			36.7			544
Complete	53.1			41.4			560
	Cramer's V=	0.07	p=<0.05	Cramer's V=	0.05	n.s.	
Immunization timing							
None	57.1			47.6			365
0-50%	46.0			34.8			545
> 50 % & < 100%	41.7			34.1			178
100%	75.3			44.9			16
	Cramer's V=	0.13	p=<0.001	Cramer's V=	0.13	p=<0.001	
Heard of ORT							
No	49.3			39.2			1195
Yes	45.5			35.9			711
	Cramer's V=	0.04	n.s.	Cramer's V=	0.03	n.s.	
Breastfeeding							
Sufficient	47.2			35.4			33
Insufficient	47.9			38.0			1872
	Cramer's V=	0.00	n.s.	Cramer's V=	0.01	n.s.	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.4.

Table 6.11: CHILDCARE AND PERCENTAGE 2SD OR MORE BELOW REFERENCE MEDIAN HT/A AND WT/A, SINGLETONS, UGANDA

	HT/A	Signif.(1)	WT/A	Signif.(1)	n
Ante-natal care					
No	49.6		26.8		436
Yes	43.1		22.1		3208
		0.04 p=<0.01		0.04 p=<0.05	
Ante-natal anti-tetanus					
No	47.1		24.3		1557
Yes	41.6		21.5		2084
		0.06 p=<0.001		0.03 p=<0.05	
Health card					
No	40.4		22.7		1198
Yes	45.6		22.7		2446
		0.05 p=<0.01		0.00 n.s.	
Immunization coverage					
None	42.2		22.3		1960
Partial	46.1		25.7		917
Complete	44.9		20.3		814
		0.03 n.s.		0.04 p=<0.05	
Immunization timing					
None	52.2		25.9		968
0-50%	41.0		22.0		530
> 50 % & < 100%	34.2		18.3		169
100%	11.6		4.5		61
		0.18 p=<0.001		0.10 p=<0.001	
Heard of ORT					
No	47.2		25.3		1994
Yes	39.8		19.7		1696
		0.07 p=<0.001		0.07 p=<0.001	
Breastfeeding					
Sufficient	44.2		22.8		3562
Insufficient	31.8		20.0		129
Cramer's V=		0.05 p=<0.01		0.01 n.s.	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.5.

Table 6.12: CHILD CARE AND PERCENTAGE 2SD OR MORE BELOW REFERENCE MEDIAN HT/A AND WT/A, SINGLETONS: ZIMBABWE

	HT/A	Signif.(1)		WT/A	Signif.(1)		n
Ante-natal care							
No	49.0			16.6			145
Yes	27.3			11.0			2182
		0.12	p=<.001		0.04	p=<.05	
Ante-natal anti-tetanus							
No	36.9			14.7			423
Yes	27.0			10.7			1872
		0.08	p=<.001		0.05	p=<.05	
Health card							
No	44.8			20.9			134
Yes	27.7			10.8			2190
		0.09	p=<.001		0.07	p=<.001	
Immunization coverage							
None	30.0			13.1			527
Partial	23.7			9.6			468
Complete	29.5			11.3			1367
		0.05	p=<.05		0.04 n.s.		
Immunization timing							
None	38.9			23.6			144
0-50%	31.6			10.8			730
> 50 % & < 100%	24.9			9.3			547
100%	20.3			7.9			379
		0.12	p=<.001		0.13	p=<.001	
Heard of ORT							
Yes	28.1			11.2			2313
No	54.1			21.6			37
		0.07	p=<.001		0.04	p=<.05	
Breastfeeding							
Sufficient	28.6			11.5			2312
Insufficient	20.0			4.0			50
Cramer's V=		0.03	n.s.		0.03	n.s.	

(1) Significance of chi-square and Cramer's V statistics.
n.s. signifies p=>0.05

SOURCE: As for Table 4.6.

immunization is given too early it could be ineffective because the desired anti-bodies may not develop.

Immunization timing also is an age-standardized variable, which indicates whether or not a correct immunization schedule was adhered to. Timing was calculated by relating date of immunization to the child's age to determine what proportion of those immunizations for which it was eligible had been received, within plus or minus two weeks of the recommended date. Only children who had received at least one vaccination are included in the tabulation for *immunization timing*. Hence *none* in this panel indicates that, although the child had received one or more immunizations, none were administered near the recommended time.

As expected, the relationship of stunting and underweight with *immunization timing* is generally negative. The exception is Burundi, where only 16 cases had received all immunizations at the correct date, and these cases had the highest prevalence of stunting and a high prevalence of underweight. It is probable that the correct timing of this small group reflects the frequent attendance at medical centres of sickly children.

Most mothers in Zimbabwe had heard of ORT, while children whose mothers had not heard of it showed twice the levels of stunting and underweight of others. The pattern is less marked in Burundi and Uganda, where it had been heard of less frequently, but still there is a highly significant relationship with growth in Uganda.

Although breastfeeding, as part of nutrition, is a direct determinant of growth, it is also a proximate determinant, as a component of child-care practices. As discussed in Chapter Three, a limitation of the DHS data sets is that it is not possible to determine the relative importance of breastmilk and supplementary foods in each child's diet. This severely limits the utility of this variable in any analysis of growth attainment.

The World Bank (1991: 36) cited a 1982 survey which found that early and inappropriate supplementation was widespread in Zimbabwe, with 84 per cent of urban children and 50 per cent of rural children under six months of age receiving supplements. This is supported by ZDHS findings, with less than 10 per cent of infants under four months old exclusively breastfed, while others received breastmilk diluted with water, or breastmilk plus other supplementation.

In the Zimbabwe survey, but not in those for Burundi and Uganda, respondents were asked the child's age when food supplementation commenced. Although not a reliable proxy for proportion of nutrition derived from breastfeeding, this variable could indicate exposure to risk of contamination. For example, a 1985 Zimbabwe Ministry of Health survey of child nutrition found that the nutritional status of children aged four to six months who were wholly breastfed was extremely good, with little wasting and stunting, while children in the same age group who were supplemented were less well-nourished. This was attributed to diarrhoea caused by early supplementation and poor food hygiene (Loewenson, 1990: 82).

The writer was told by a group of Zimbabwean women that it was the custom of older women to pour diluted porridge into the palm of their hand and tip it into the mouths of newborns in the first few days of life. The group had been taught that this was wrong, but said that, although they would not do it themselves, it still occurs. This presents an opportunity for exposure to contamination early in life that may not be detectable in the ZDHS. It is likely that some DHS respondents would not have reported this supplementation, either because they knew it was wrong or because it occurred for only a few days and so was not classed as supplementation.

In addition to potential misreporting, the small number of cases precludes a meaningful comparison of the growth attainment of the two groups using ZDHS. All but seven of the 118 children aged from four to six months had received supplementation at age four months or less, and there was no significant difference in the proportions who were stunted or underweight.

In view of these limitations, *breastfeeding* is treated here as an age-standardized variable with only two categories, *sufficient* and *insufficient*. It was classified as sufficient if a child under age six months was still being breastfed, or a child over six months had been breastfed for at least six months. Not surprisingly, this variable is not significantly related to stunting and underweight, as most children in all three countries had been breastfed for more than a year. A confounding factor is that some of those weaned early are probably the children of wealthier, working mothers who elected to bottlefeed. Hence, in some cases, insufficient breastfeeding could be a proxy for higher socio-economic status.

The Cramer's V statistics show that the relationship of child-care variables with stunting and underweight tends to be weak, generally below 10 per cent. In all three countries the value was highest for *immunization timing*.

Tables 6.1 to 6.12 present an interesting contrast with children born in the five years preceding the surveys in Tables 4.4 to 4.15, for whom the same groups of variables are cross-tabulated, but with percentage dead as the dependent variable rather than Ht/A and Wt/A. Although the numbers of cases born in the five years preceding the surveys are larger in Chapter Four (as dead children are included in the analysis), there are substantially fewer significant relationships with socio-economic and environmental factors.

Two exceptions are *number in household* and *number of children under five years*. In each country these variables have a significant negative association with percentage dead, but a weaker or insignificant relationship with Ht/A and Wt/A. This is because the number of children and adults in the household is partially determined by the number of deaths. On the other hand, Ht/A of surviving children in Uganda is significantly better when there are more births in the past five years and households are larger. This contrasts with Zimbabwe, where more births are associated with higher percentages of low Ht/A.

With the exception of *preceding* and *succeeding birth interval*, demographic factors more often have a highly significant association with survival than with growth attainment. This is true for all three countries, although there are differences between countries in the variables appearing as highly significant. This contrast between the factors associated with survival and those associated with low Ht/A and Wt/A is striking. In particular, it suggests that the -2 SD Z-score cut-off points for Ht/A and Wt/A are not good predictors of mortality risk.

It is possible that very low Z-score cut-off points, such as -3.5 SDs or -4 SDs might have produced patterns more like those for mortality, but there were insufficient cases with very low scores to yield significant results. Another possibility is that, had there been enough cases and a way of controlling for censoring, an analysis of -2 SDs Wt/Ht, rather than Ht/A and Wt/A, would have produced associations comparable with those for mortality. However, since -2 SDs Ht/A and Wt/A are widely used as cut-off points to signify poor growth attainment, the present analysis points to the need to include other characteristics in risk assessment when resources for intervention and assistance are limited.

6.3 ANALYSIS OF DATA: MULTI-VARIATE

In keeping with the objective of exploring appropriate methods for analyzing anthropometric data, as well as identifying the most important correlates, two multi-variate techniques are compared here. The first approach is logistic regression, with growth attainment treated as a bi-nomial dependent variable, and the second is OLS regression, with growth attainment treated as a continuous dependent variable. All variables from the bi-variate analysis were considered for inclusion as independent variables in both models.

6.3.1 Logistic regression

Logistic regression is widely used for the analysis of dichotomous dependent variables. The subject of the analysis is the proportion of cases which possess the characteristic under investigation. One advantage of the logistic regression approach is that relationships between variables are compared with reference to a logistic curve, lying between 0 and 1, rather than a straight line, so negative predicted values do not occur. A second advantage is that, as in the Cox's regression technique used in Chapter Four, the resulting estimates can be exponentiated to produce odds in relation to a reference category, which are more easily interpreted than OLS regression co-efficients. The logistic regression procedure is explained in detail in Healy (1988).

The software package used for this analysis was the mainframe release of GLIM Version 3.77 (Update 2, Royal Statistical Society of London, 1985). The two dependent variables, Ht/A and Wt/A, were classified as up to and above the conventional cut-off point, 2 SDs below the reference value.

A limitation of the logistic regression procedure in GLIM is that models can be built only with cases which have valid responses for all selected variables. It was therefore necessary to discard around 5 per cent of cases from each of the data sets. Multiple births also were excluded from the analysis, because of their tendency to exhibit erratic growth patterns. *Preceding* and *succeeding birth interval* were grouped, as in Chapter

Four, with four categories, one of which is *no preceding* (or *succeeding) birth interval*, to avoid undue reduction in the sample size, or bias towards younger or older children.

Also, as in Chapter Four, similar categories of non-interval variables are combined. The largest category is treated as the reference category, since this minimises standard error estimates and simplifies the interpretation of odds. The reader should note that the reference category for some variables, for example *literacy*, differs between countries. The reference categories for all variables in the models are shown in Table 6.13.

Table 6.13: BASE CATEGORIES FOR LOGISTIC REGRESSION

	BURUNDI	UGANDA	ZIMBABWE
Child's age	*Interval*	*Interval*	*Interval*
Ante-natal anti-tetanus	No	Yes	Yes
Ante-natal care	No	Yes	Yes
Dead sibling	No	No	No
Birth order	*Interval*	*Interval*	*Interval*
Breastfeeding	Sufficient	Sufficient	Sufficient
Mother working	No	No	No
Husband's occupation	Agriculture	Agriculture	Manufacturing
Electricity	No	No	No
Owns refrigerator	No	No	No
Sex of child	Male	Male	Male
Mother's age	*Interval*	*Interval*	*Interval*
Region	Central Plateau	South West	Manicaland
Residence	Rural	Rural	Rural
Mother's education	None	Primary	Primary
Mother's literacy	No or weak	No or weak	Reads
Husband's education	None	Primary	Primary
Husband's Literacy	No or weak	Reads	Reads
Health card	Yes	Yes	Yes
Water source	Well	Well or bore	Bore
Distance to water	*Interval*	< .25 mile	.1-1 km
Type of toilet facility	Pit latrine	Pit latrine	None
Soap on premises	Yes	Yes	-
Number of other wives	-	*Interval*	-
Language	-	-	Shona
Strata	-	-	Communal
Religion	-	Catholic	Christian
Number in household	*Interval*	*Interval*	*Interval*
No. of children under 5yrs	*Interval*	*Interval*	*Interval*
Births in past 5 yrs	*Interval*	*Interval*	*Interval*
Immunization	None	None	Fully Immunized
Heard of ORT	Yes	No	Yes

The addition of *child's age* to the models yielded little change in deviance, even though Z-scores clearly decline with increasing child's age. This is because logistic regression is concerned with linear relationships, while the relationship of *child's age* with growth attainment is non-linear. Figures 6.1, 6.2 and 6.3 depict the percentage of measured children in each one month age group who were 2 SDs or more below the reference value. For Zimbabwe Ht/A and Wt/A and Uganda Wt/A the patterns are clearly non-linear, whereas there is a slight linear trend for Burundi Ht/A and Wt/A and Uganda Ht/A. In the case of Burundi, this can be explained by the narrower age range of measured children.

A quadratic term, the square of the *child's age*, was therefore added to each model, in addition to *child's age*, to adjust for non-linearity. The combination of *child's age* and *child's age squared* is a better representation of the age pattern, and produces a significant change in deviance in all three countries.

To test for interactions, each independent variable was fitted to the model, and then all other remaining variables added and then removed one by one. The results of this procedure were recorded in a matrix which was used to calculate the change in deviance produced by the addition of each variable, and to identify interactions. A chi-square table of significant values was used to select those which produced a significant reduction in scaled deviance. Significant independent variables and interactions were then added to the model, one at a time, and their significance evaluated.

The last stage of modelling was to add significant variables and interactions, in order, according to how much they reduced the scaled deviance. That is, those with the strongest effects cancelled out related variables and interactions with weaker effect. Surprisingly, although a number of interactions appeared significant in the matrix described above, the independent effects of other variables cancelled out the effects of all except one interaction term.

The only interaction which remained significant was *region* with *electricity* in Burundi. However, although *electricity* significantly reduced the odds of poor growth attainment in the Central Plateau and Imbo, only six cases in each of these two regions came from households with electricity. Hobcraft (1991: 1159) applied the population attributable

Figure 6.1A: PERCENTAGE STUNTED, BURUNDI

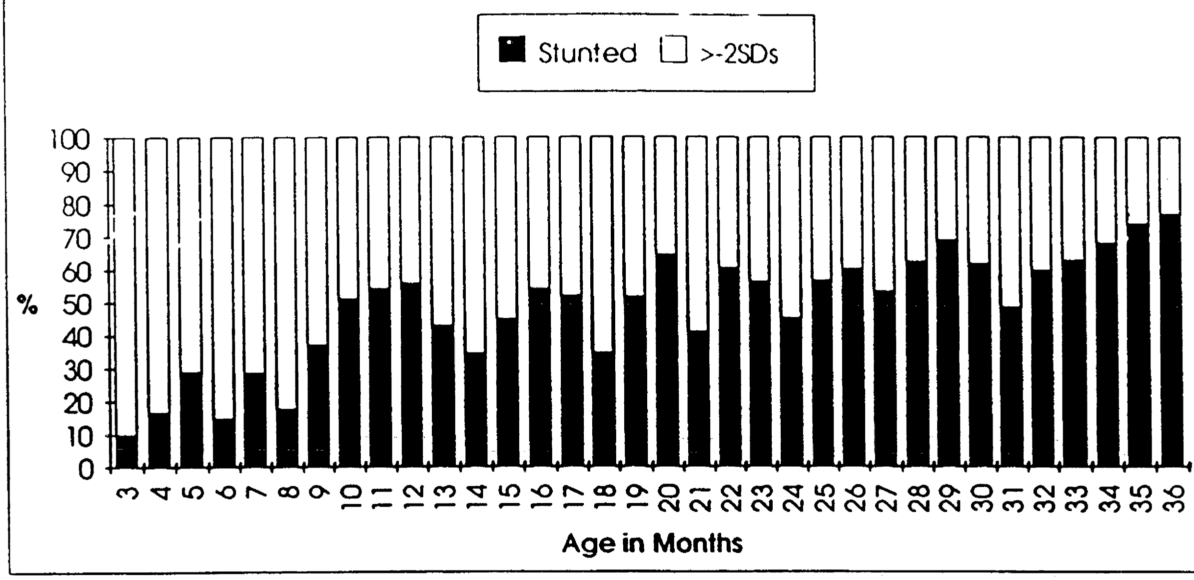
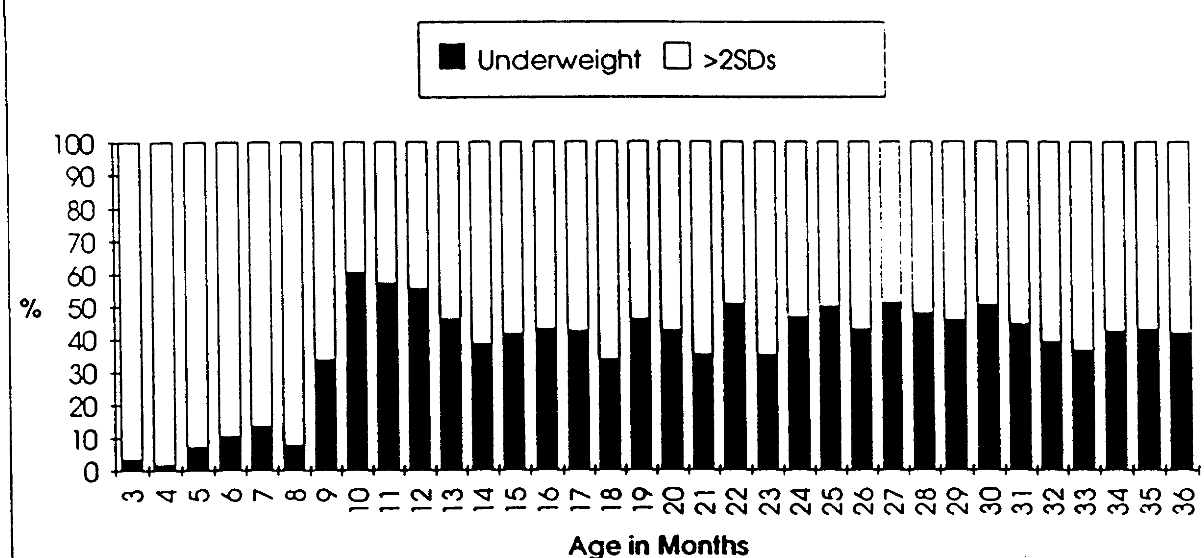


Figure 6.1B: PERCENTAGE UNDERWEIGHT, BURUNDI



SOURCE: As for Table 4.4.

Figure 6.2A: PERCENTAGE STUNTED, UGANDA

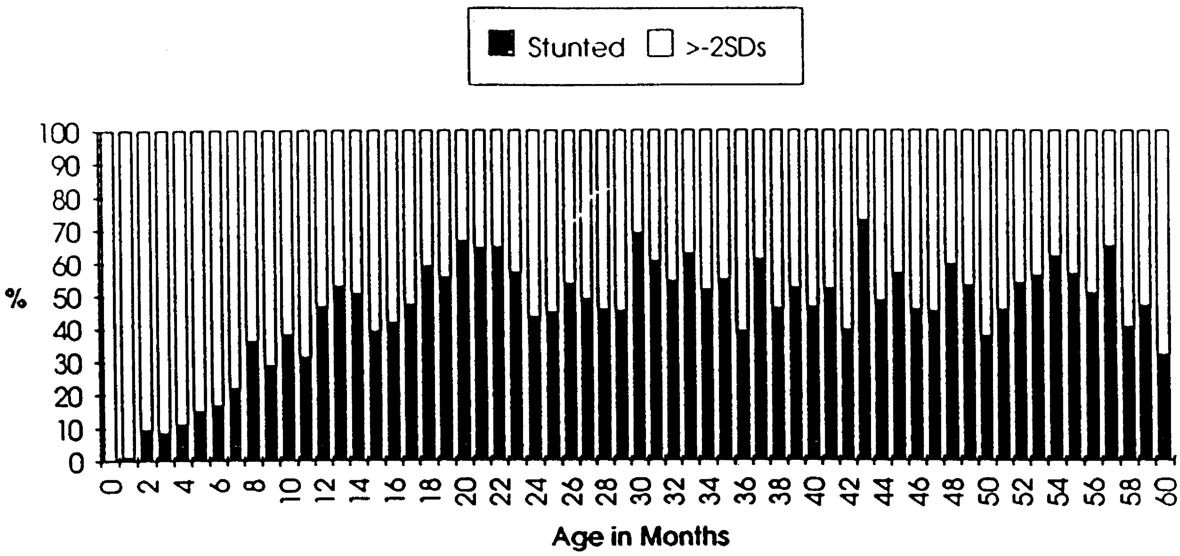
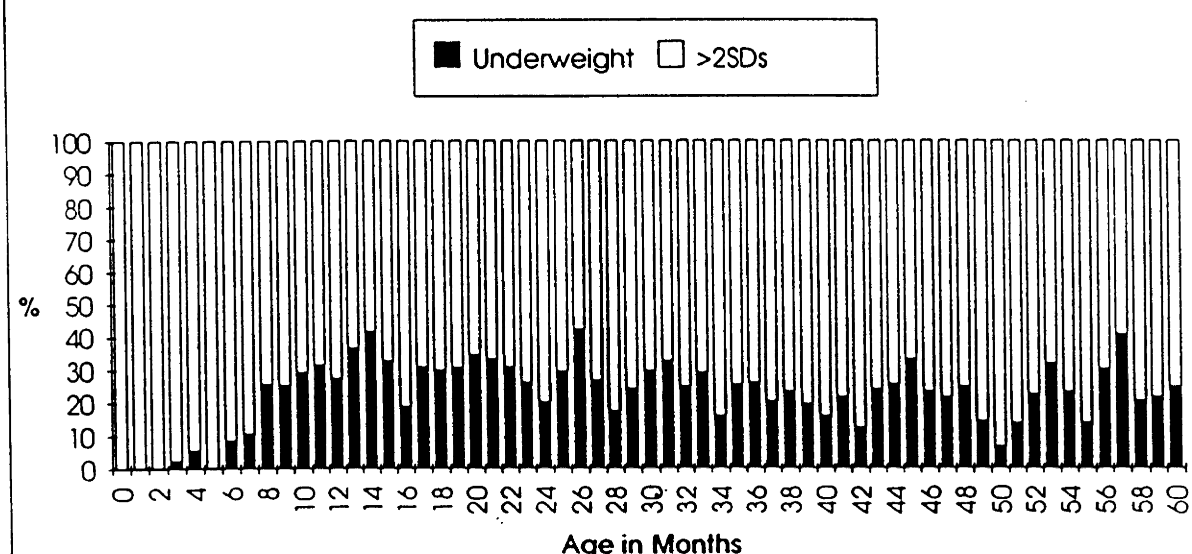
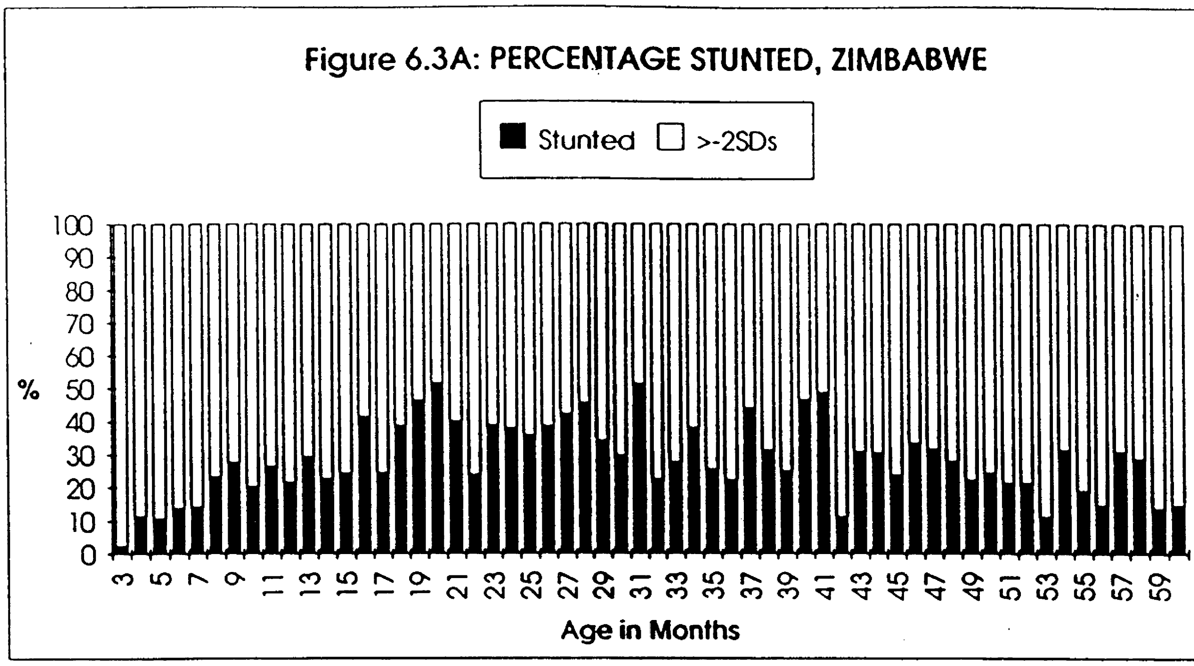
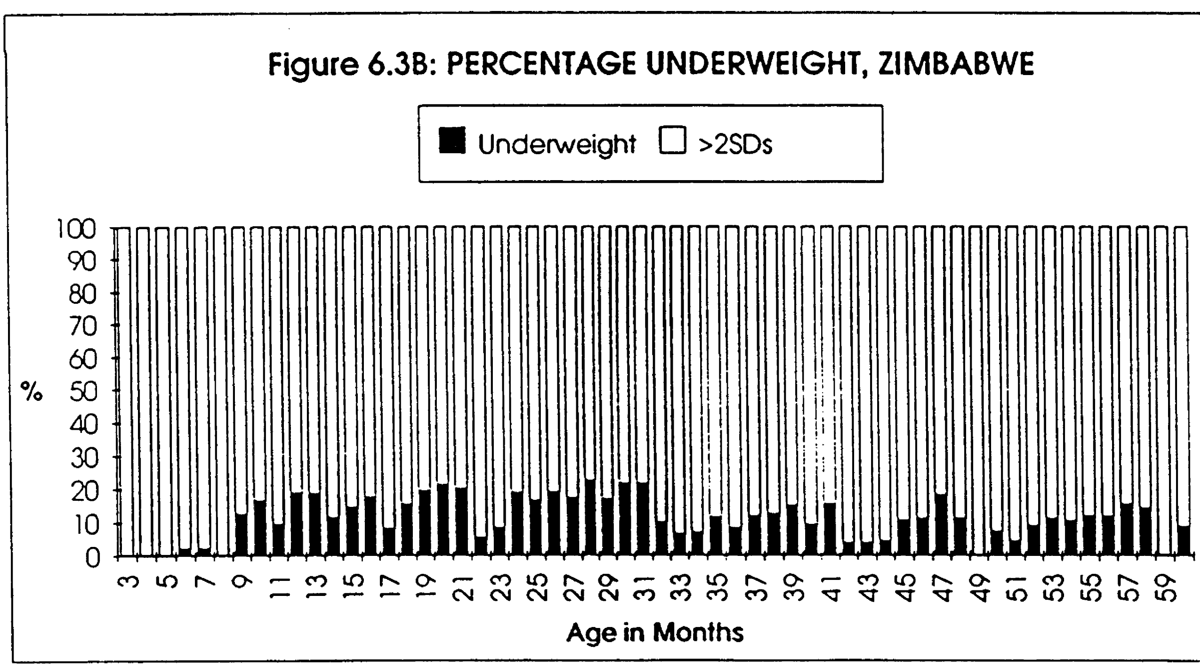


Figure 6.2B: PERCENTAGE UNDERWEIGHT, UGANDA



SOURCE: As for Table 4.5.





SOURCE: As for Table 4.6

risk (PAR) technique[1] to demonstrate that where excess risks applied to only a small number of births, the potential effect on the population as whole was very modest. Similarly, in the case of Burundi, this interaction term was considered to have only very modest implications for the sample as a whole, so was dropped from the model in the interests of parsimony. The final models thus contain only those variables with the strongest effects.

Tables 6.14, 6.15 and 6.16 show the logistic regression models for the three countries. The third column shows the calculated odds of children in each category being stunted or underweight compared with the reference category, which has the odds of 1.00. After *child's age* and *child's age squared*, which appear in all models, the most frequently occurring variables are *region* (or *strata* in the case of Zimbabwe) and *preceding birth interval*. *Region*, or *strata*, appear in every model, and *preceding birth interval* in all but Wt/A for Zimbabwe. Next most frequently occurring are *mother's education* or *literacy*, *succeeding birth interval* and *rural or urban residence*. *Mother's* and *husband's occupation*, *mother's age*, *child's sex* and *drinking water source* each appeared in one model.

Except in Burundi, children in urban areas or regions containing significant urban centres tend to have the lowest odds of being stunted or underweight compared with those in predominantly rural areas. In Burundi, where very poor living conditions exist in the urban townships of Bujumbura, children in Imbo province are only a little less likely to be stunted than children from the Central Plateau region, although rather less likely to be underweight. The most advantaged provinces are the mountain and valley provinces. This is consistent with Hiernaux's (1974: 66) observation that mountain people in Burundi tend to have better diets and to be heavier than people of the same ethnic group in lowland areas. Ugandan children in Kampala and Central regions are least likely to be stunted, while children in the East are least likely to be underweight. Urban children in Uganda are consistently better off than rural children, as regards both stunting and underweight.

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1 The procedure for calculating the PAR is to divide the odds of the base estimate for each variable by the odds for the model with only a constant term fitted. Where the resulting value is close to 100, say ± 5, or even ± 10, the population attributable risks are considered low, and the implications for the population as a whole are minor.

Table 6.14: RELATIVE RISK OF BEING 2SD OR MORE BELOW REFERENCE MEDIAN HT/A AND WT/A, BURUNDI

	Estimate	S.E.	Odds
HT/A			
Base	-0.4257	0.8755	1.00
Child's age	0.1375	0.0269	1.15
Child's age2	-0.0020	0.0007	1.00
Husband's occupation			
Agriculture			1.00
Prof./tech./cler.	-1.0480	0.4085	0.35
Retailing	-0.2321	0.2032	0.79
Manufacturing	-0.0606	0.1793	0.94
Never worked	0.8010	0.7708	2.23
Region			
Central Plateau			1.00
Mumirwa	-1.1320	0.8662	0.32
Mugamba	-1.5260	0.8726	0.22
Imbo	-0.0421	1.0280	0.96
Depressions	-1.3570	0.8632	0.26
Preceding birth interval			
24-35 mths			1.00
0-23 mths	0.2758	0.1640	1.32
No previous birth	0.3127	0.1625	1.37
36 + mths	-0.1418	0.1296	0.87
WT/A			
Base	-0.1803	1.0780	1.00
Child's age	0.2588	0.0291	1.30
Child's age2	-0.0056	0.0007	0.99
Region			
Central Plateau			1.00
Mumirwa	-2.8200	1.0650	0.06
Mugamba	-2.8410	1.0680	0.06
Imbo	-1.9710	1.2030	0.14
Depressions	-2.8000	1.0630	0.06
Preceding birth interval			
24-35 mths			1.00
0-23 mths	0.4359	0.1656	1.55
No previous birth	-0.1442	0.1639	0.87
36 + mths	-0.0603	0.1332	0.94

SOURCE: As for Table 4.4.

Table 6.15: RELATIVE RISK OF BEING 2SD OR MORE BELOW REFERENCE MEDIAN HT/A AND WT/A, UGANDA

HT/A

	Estimate	S.E.	Odds
Base	-0.2104	0.3809	
Child's age	0.151	0.01058	1.16
Child's age2	0.00199	0.000168	1.00
Region			
South West			1.00
East	-0.5095	0.1013	0.60
Central	-0.8827	0.1108	0.41
West	-0.3332	0.1688	0.72
West Nile	-0.6196	0.1809	0.54
Kampala	-0.8954	0.3246	0.41
Succeeding birth interval			
None			1.00
1-23 mths	-0.86	0.1383	0.42
24-35 mths	-0.4124	0.1291	0.66
36+ mths	0.2497	0.2241	1.28
Drinking water source			
Well or bore			1.00
Piped to residence	-1.801	0.8412	0.17
Outside tap	0.1106	0.2308	1.12
Surface, other	0.251	0.08139	1.29
Preceding birth interval			
24-35 mths			1.00
1-23 mths	0.1837	0.1032	1.20
No previous birth	-0.09648	0.1344	0.91
36 mths +	-0.3108	0.1056	0.73
Male			1.00
Female	-0.2353	0.07908	0.79
Mother's age	-0.01853	0.006951	0.98
Rural			1.00
Urban	-0.5939	0.2516	0.55
Mother's education			
Primary			1.00
None	-0.04547	0.08444	0.96
Secondary +	-0.5335	0.1864	0.59

WT/A

	Estimate	S.E.	Odds
Base	0.9009	0.3472	
Child's age	0.09876	0.0117	1.10
Child's age2	-0.00146	0.000193	1.00
Region			
South West			1.00
East	-0.5221	0.1136	0.59
Central	-0.4196	0.1199	0.66
West	-0.231	0.1911	0.79
West Nile	0.04251	0.1651	1.04
Kampala	-0.3513	0.3991	0.70
Succeeding birth interval			
None			1.00
1-23 mths	-0.8015	0.1629	0.45
24-35 mths	-0.458	0.1413	0.63
36+ mths	0.457	0.2268	1.58
Mother illiterate			1.00
Mother literate	-0.3604	0.0905	0.70
Preceding birth interval			
24-35 mths			1.00
1-23 mths	0.2657	0.1137	1.30
No previous birth	0.2001	0.1352	1.22
36 mths +	-0.2058	0.1198	0.81
Rural			1.00
Urban	-0.6294	0.2859	0.53

SOURCE: As for Table 4.5.

Table 6.16: RELATIVE RISK OF BEING 2SD OR MORE BELOW REFERENCE MEDIAN HT/A AND WT/A, ZIMBABWE

HT/A	Estimate	S.E.	Odds
Base	-1.8490	0.2199	1.00
Child's age	0.1063	0.0147	1.11
Child's age2	0.0017	0.0002	1.00
Strata			
Communal			1.00
Large commercial	0.1097	0.1455	1.12
Urban	-1.0380	0.1594	0.35
Resettlement	0.6230	0.2654	1.86
Small commercial	-0.1938	0.5426	0.82
Mother's occupation			
Never worked			1.00
Prof./tech.	-1.4060	0.5270	0.25
Clerical/sales/service	-0.1783	0.2366	0.84
Agriculture	-0.2406	0.1427	0.79
Manufacturing	-0.4394	0.1902	0.64
Preceding birth interval			
24-35 mths			1.00
1-23 mths	0.2728	0.1509	1.31
No previous birth	-0.0357	0.1529	0.96
36+ mth	-0.1996	0.1283	0.82

WT/A	Estimate	S.E.	Odds
Base	-3.8340	0.4246	1.00
Child's age	0.0940	0.0213	1.10
Child's age2	-0.0015	0.0003	1.00
Strata			
Communal			1.00
Large commercial	-0.2812	0.2250	0.75
Urban	-1.2770	0.3505	0.28
Resettlement	0.5711	0.3725	1.77
Small commercial	-0.8429	1.0430	0.43
Region			
Manicaland			1.00
Mashonaland East	-0.0216	0.2862	0.98
Mashonaland West	0.4040	0.2867	1.50
Matableland North	-0.3459	0.3917	0.71
Matableland South	-0.0380	0.3304	0.96
Midlands	0.5163	0.2522	1.68
Masvingo	-0.3516	0.2892	0.70
Harare/Chitungwiza	-0.5512	0.8035	0.58
Bulawayo	0.1588	0.6383	1.17
Mashonaland Central	0.3915	0.3031	1.48
Mother's education			
Primary			1.00
Secondary	-0.0632	0.2614	0.94
None	0.5731	0.1732	1.77

SOURCE: As for Table 4.6.

In Zimbabwe, resettlement areas produce the highest odds of stunting and wasting. Children on large commercial farms also are more likely to be stunted than those on communal land, but the reverse is true for underweight. As there are several different strata in each region, *strata* does not wholly account for regional differences in the odds of being underweight in the Zimbabwe model. However, the risk is highest in Midlands and Mashonaland Central and West, where both resettlement areas and commercial farming occur. Children also are more likely to be underweight in the urban area of Bulawayo than in Harare / Chitungwiza, where the odds are the lowest of all regions. This is consistent with the World Bank (1991: 5) report that 11 per cent of Bulawayo children aged 12-23 months were below the 3rd centile Wt/A in 1990, compared with only 2 per cent in Chitungwiza and 5 per cent in Harare.

Children with preceding birth intervals of less than 24 months have the highest odds of poor growth attainment, except for Burundi Ht/A, where first births are very slightly disadvantaged compared to those with a short preceding interval. Children with a preceding birth interval of 36 months or longer tend to be least likely to be disadvantaged. The adverse effect of a short preceding birth interval on growth attainment almost certainly reflects competition from siblings who have similar needs.

On the other hand, the pattern for succeeding birth interval, which appears only for Uganda, is the reverse. Children with the longest succeeding birth intervals have the highest risk of being stunted and underweight. As discussed above, this probably reflects both the deterioration in Z-scores with age, and the greater possibility of hardship or family breakdown where no births have occurred. However, although it is statistically significant, it would be unwise to draw firm conclusions about this effect, since only around 5 per cent of cases were in this category, as shown in Table 6.5.

The effect of the other independent variables in the models tends to be in the expected direction. Burundais children in families where the husband's occupation is professional or technical are much less likely to be stunted than those in all other categories, while children in families where the husband had never worked are more than twice as likely to be stunted as those in agricultural families. The pattern was similar, although less extreme, for *mother's occupation* in Zimbabwe. *Occupation* does not feature in the models for Uganda, but where a mother has secondary education or is literate the child's chances of being stunted or underweight are reduced. A mother with secondary education also reduces childrens' odds of being underweight in Zimbabwe. In Uganda, the effect of *source of drinking water* is significant for stunting, with the highest odds associated with surface water or shared outside tap. Ugandan female children and children with older mothers are a little less likely to be stunted.

The predominance of socio-economic and environmental variables in these models is in striking contrast to the models for the odds of dying in Table 4.20. Only demographic variables or those pertaining to family or household size appeared in the Cox's regression models of the odds of dying. The models in Tables 6.14, 6.15 and 6.16 suggest that, while there is an age effect, the risk of stunting and underweight is most closely associated with a cluster of socio-economic and environmental variables. The strongest of these, *region* (or *strata*) and *mother's* or *husband's education* or *occupation*, tend to cancel out most other socio-economic and environmental characteristics. Besides *child's age* and *child's age squared*, the only demographic variable appearing consistently is *preceding birth interval*.

Part of the explanation for the difference in the models appears to lie in the different association of mortality and poor growth attainment with age. Whereas highest mortality occurs amongst children aged less than one year, stunting and underweight tend not to manifest until after children have attained their first birthday. Hence the sample of dead children is biased towards younger ages, whereas those with poor growth attainment tend to be aged one year or more. The different effect of *succeeding birth interval* in the models for mortality and growth attainment is because it reflects the replacement effect in the case of the former and age bias in the case of growth attainment.

6.3.2 Ordinary Least Squares (OLS) regression

The logistic regression procedure described above required the transformation of the interval dependent variables Ht/A and Wt/A into dichotomous variables by classifying Z-scores into those cases 2 SDs or more below the reference value and those above -2 SDs. In this section OLS regression is used to compare the results obtained when Ht/A and Wt/A are treated as interval dependent variables.

The selection and coding of independent variables for the OLS regression was the same as for the logistic regression. However, this technique requires categorical variables to be transformed into a series of dummy variables. This has the advantage of separating significant categories from those which have insignificant effects, and may result in the inclusion of categories from a wider range of variables than in logistic regression models. *Preceding* and *succeeding birth interval* were each treated as three dummy variables, rather than as interval variables, with *first born* or *no succeeding birth interval* as the reference category. This was because the effect of birth interval tends to be non-linear, and treating them as categorical allows the effect of short, medium and long birth intervals to be distinguished more clearly.

Variables were entered into the model one by one in a stepwise procedure, with a tolerance criterion of 0.5, to avoid inappropriate estimates from correlated variables. Variables which did not meet the criterion were excluded from the equation. As in the logistic regression, both *child's age* and *child's age squared* were included to allow for the non-linear association of growth attainment with age. Tables 6.17, 6.18 and 6.19 show the regression estimates for significant variables in the order they were entered into the model, that is, strongest effects first.

Perhaps the most obvious feature of all six models is that socio-economic, demographic, environmental and child-care variables explain only a small amount of the variation in Z-scores. Tables 5.16 and 5.17 in Chapter Five showed that simple regressions of *child's age* with Ht/A and Wt/A produced very low r^2 values. Even with the addition of the socio-economic, demographic and environmental variables, the r^2 values are still low, ranging from only 0.09 for Wt/A in Burundi and Uganda to 0.16 for Uganda Ht/A.

Child's age has the strongest effect in Burundi, while in Uganda and Zimbabwe *child's age squared* consistently has either the strongest or close to the strongest effect. In every case, either *child's age* or *child's age squared* has a pronounced negative relationship with Z-score. This reflects the deterioration over time, as depicted in Figures 5.10 and 5.15.

Other variables appearing in the models are predominantly those related to environmental conditions and birth interval. There tend to be more demographic and fewer socio-economic variables than in the logistic regression models.

The positive effect of a preceding birth interval of 36 months or more, or the negative effect of a preceding interval of less than 24 months, appears in each of the six models. This emphasizes the importance of sibling competition as a factor impairing growth

Table 6.17: REGRESSION MODELS OF HT/A AND WT/A: BURUNDI

HT/A		B	T	Sign. T
Child's age		-0.0419	-0.137	0.000
Electricity		0.9302	0.031	0.002
Succeeding interval < 24 mths		0.5909	0.042	0.000
Birth order		0.0315	0.020	0.041
Imbo		0.3719	0.030	0.003
Preceding interval < 24 mths		-0.2539	-0.027	0.007
No soap in house		-0.2059	-0.025	0.014
Preceding interval 36 mths +		0.1742	0.024	0.014
Dead sibling		0.1659	0.022	0.030
Husband secondary educated		0.3549	0.022	0.031
Constant		-1.3049	-0.145	0.000
Adj r2	0.123			
n	1903			

WT/A		B	T	Sign. T
Child's age		-0.0336	-0.115	0.000
Electricity		0.9669	0.044	0.000
Imbo		0.3696	0.037	0.000
Depressions		0.2311	0.033	0.001
Preceding interval < 24 mths		-0.1896	-0.026	0.009
Succeeding interval < 24 mths		0.3607	0.031	0.002
Succeeding interval 24-35 mths		0.3004	0.029	0.003
No soap in house		-0.1609	-0.024	0.019
Constant		-1.0048	-0.174	0.000
Adj r2	0.092			
n	1903			

Table 6.18: REGRESSION MODELS OF HT/A AND WT/A, UGANDA

HT/A		B	T	Sign. T
Child's age2		-0.2956	-0.171	0.000
South West Province		-0.4362	-0.075	0.000
Succeeding interval <24 mths		0.7321	0.085	0.000
Mother's age		0.0133	0.032	0.002
Urban		0.3904	0.037	0.000
Preceding interval 36 mths +		0.2093	0.035	0.001
Succeeding interval 24-35 mths		0.3353	0.044	0.000
Female		-0.1676	-0.034	0.001
Insufficient breastfeeding		0.5337	0.031	0.000
Surface drinking water source		-0.1513	-0.030	0.000
Central Province		0.2038	0.032	0.002
Flush toilet		0.4823	0.027	0.006
Protestant		-0.1488	-0.030	0.003
Number in household		0.0506	0.046	0.000
Number of children < 5 years		-0.1245	-0.040	0.001
Distance to drinking water		0.0563	0.024	0.017
Constant		-0.8627	-0.058	0.000
Adj r2	0.163			
n	3145			

WT/A		B	T	Sign. T
Child's age2		-0.1882	-0.133	0.000
Urban		0.3176	0.032	0.002
Succeeding interval <24 mths		0.6471	0.090	0.000
Succeeding interval 24-35 mths		0.4149	0.065	0.000
South West Province		-0.1896	-0.043	0.000
Preceding interval 36 mths +		0.1619	0.033	0.001
Number in household		0.0442	0.051	0.000
Number of children < 5 years		-0.0973	-0.038	0.000
Mother 2y education		..17494224	0.020	0.046
Female		-0.0996	-0.024	0.016
Distance to drinking water		0.0394	0.020	0.045
Electricity		0.2355	0.020	0.047
Constant		-0.5063	-0.051	0.000
Adj r2	0.090			
n	3145			

Table 6.19: REGRESSION MODELS OF HT/A AND WT/A, ZIMBABWE

WT/A		B	T	Sign. T
Urban		0.5088	0.070	0.000
Mother secondary education		0.2542	0.035	0.000
Child's age2		-0.0487	-0.032	0.000
Refrigerator		0.3645	0.037	0.000
Preceding interval 36 mths +		0.1296	0.023	0.020
Bulawayo		-0.3232	-0.028	0.005
Resettlement area		-0.3886	-0.027	0.007
Husband not educated		-0.1904	-0.023	0.020
Fully immunized		-0.1610	-0.031	0.002
Female		-0.1133	-0.023	0.020
Pit toilet		-0.1715	-0.024	0.017
Language: English or other		-0.3956	-0.024	0.016
Ante-natal care		0.2043	0.022	0.031
Preceding interval <24 mths		-0.1496	0.021	0.035
Constant		-1.2865	-0.101	0.000
Adj r2	0.095			
n	2358			

WT/A		B	T	Sign. T
Flush toilet		0.4515	0.073	0.000
Child's age2		-0.1851	-0.105	0.000
Refrigerator		0.3538	0.040	0.000
Husband in service work		-0.1219	-0.023	0.029
Language English or other		-0.4470	-0.031	0.002
Mother secondary education		0.2076	0.031	0.002
Fully immunized		-0.1254	-0.028	0.001
Blair toilet		0.1636	0.028	0.005
Preceding interval <24 mths		-0.1469	-0.025	0.014
Succeeding interval 24-35 mths		0.3067	0.043	0.000
Mother's age		0.0103	0.031	0.002
Husband no education		-0.1709	-0.023	0.020
Ndebele		0.1699	0.028	0.005
Succeeding interval < 24 mths		0.2939	0.032	0.001
Succeeding interval 36 mths +		0.2928	0.031	0.002
Number of children under 5yrs		-0.0608	-0.027	0.007
Masvingo		0.1308	0.020	0.045
Constant		-0.1258	-0.009	0.034
Adj r2	0.144			
n	2358			

attainment. The positive effect of a short succeeding birth interval on growth attainment is an age effect, as discussed above. The addition of *preceding* and *succeeding birth interval* to the models for the three countries improved the r^2 values substantially for all three countries, increasing them by up to 0.05.

The effect of the remaining variables is generally in the expected direction, except for *insufficient breastfeeding* in Uganda, which has a positive effect, and *fully immunized* in Zimbabwe, which has a negative effect. *Dead sibling* appears only in the Ht/A model for Burundi, and has a positive effect, reflecting reduced sibling competition. The strong positive effect of *insufficient breastfeeding* for Uganda Ht/A almost certainly reflects wealthier households, as does the positive effect of larger households, which tend to be wealthier with better access to food.

The negative effect of *fully immunized* in Zimbabwe appears inconsistent, but can be explained by the age bias introduced by this variable. Although immunization coverage is widespread in Zimbabwe, only one third of all children for whom heights and weights were available had received all of the immunizations for which they were eligible. Of these, only 61 children had received all of their immunizations at the recommended time. Hence this group is biased towards older ages, for whom the risk of stunting and underweight is greater.

Fewer variables met the tolerance criterion in the models for Burundi than in the other countries. Most reflect the positive effect of living in an advantaged family or district and having a longer birth interval. The negative effect of *no soap in the house* would appear to be directly related to hygiene practices. This variable does not feature in the model for Uganda, where most households have soap, and was not available for Zimbabwe, where it can be assumed that virtually all households have soap.

In the Ugandan models *South West Province* has a negative effect on both Ht/A and Wt/A, while *urban residence* has a positive effect on both indicators. Other environmental variables in the Ugandan models relate to sanitation and crowding. The positive effects on Wt/A of *electricity* and *husband working for the government* can be considered proxies for higher socio-economic status. *Protestant religion* has a negative relationship with Ht/A, compared to the reference category, which is *Catholic*.

Mother's and *husband's education* feature in both the Ht/A and Wt/A models for Zimbabwe, with the negative effect of *husband in service work* apparent in the model for Wt/A. Speaking English or any language other than Shona or Ndebele has a negative value in both Zimbabwe models, indicating the disadvantaged position of ethnic minorities. Speaking Ndebele, rather than Shona or a minority language, and living in Masvingo both produced positive values in the Wt/A model. The only *strata* variable in the model is *resettlement area*, which is negatively related to Ht/A.

It is interesting that, when *place of residence* is treated as a dichotomous variable (Table 6.9), urban residence has a strong positive relationship with Ht/A and Wt/A. On the other hand, living in municipal Bulawayo has a negative effect on Ht/A in the OLS regression model. This is consistent with the large size and economic advantage of the Harare / Chitungwiza urban complex, which offset the disadvantages of Bulawayo. According to FAO (1990: 10), the overall percentage of under-fives in Bulawayo who were more than 2 SDs below the reference value for Ht/A was 19 per cent, but the figure climbed to 26 per cent of children aged 24-35 months and 25 per cent of children aged 36-47 months, exceeding the overall rates for neighbouring Matabeleland North and South. Cross-tabulations of province with other variables (not shown) suggest that these provinces do not appear in the model because most of their negative association with growth attainment is captured by other variables, such as *husband not educated, type of toilet facility* and *strata*, but this does not occur in the case of Bulawayo.

When the logistic regression models are compared with the OLS regression models, it is apparent that there are many similarities. Most variables in the logistic regression models are represented by at least one dummy variable in the OLS regression models. The exceptions are *husband's occupation* in Burundi Ht/A, *mother's education* in Uganda Ht/A, *mother's literacy* in Uganda Wt/A, *mother's occupation* in Zimbabwe Ht/A, and *strata* in Zimbabwe Wt/A. The OLS regression models include a wider range of variables, as categories are handled separately, but the common variables and categories almost always act in the same direction in both types of model.

It is notable that generally there was no increase in the number of demographic variables in the OLS models compared with the logistic regression models. On the basis of the substantial literature on mortality rates for malnutrition grades based on Wt/A (for example, Kielmann and McCord, 1978: Chen, Chowdhury and Huffman, 1980; Heywood, 1982; Mosley and Chen, 1984), it was expected that a technique which treats stunting and underweight as interval rather than dichotomous variables would produce models resembling those for mortality in Chapter Four. That this did not occur suggests that, in the three study countries, stunting and underweight are not in themselves good predictors of mortality risk.

It must be remembered that too few cases were more than 2 SDs below the reference value for Wt/Ht for meaningful analysis, although wasting is generally considered to be the most reliable indicator of present malnutrition (Waterlow et al., 1977). It is possible that models for Wt/Ht would have been more like those for mortality. This point will be considered further in Chapter Seven, which explores clustering of mortality, stunting, underweight, wasting and low birthweight in households.

The regression procedure was repeated using raw weight and height as the dependent variables, to compare the pattern when *child's age* is unstandardized. The results are shown in Tables 6.20, 6.21 and 6.22. The adjusted r^2 values all increase to around 0.80 or more, except for raw height in Burundi, for which the r^2 is 0.66. This is because *child's age* contributes most to the r^2 values for the raw measurements, but its effect is controlled when Z-scores are used in the model, because they are age standardized. Obviously, the effect of *child's age* in the raw models is positive, whereas it is negative in the Ht/A and Wt/A models. The substantially larger B values are because they are expressed in centimetres or kilograms, rather than standard deviations. Aside from the increase in r^2 values, there are some differences in the order and composition of the independent variables, particularly an increase in the number of socio-economic and environmental variables.

Being female has a positive effect in the Burundi raw height model, while *distance to drinking water* and *succeeding birth interval of 24-35 months* have negative effects. These variables displace the positive effect of *birth order,* which appeared in the Ht/A model. *Female, piped water* and *husband in clerical occupation,* with positive effects, and the negative effect of *distance to drinking water* are added to the raw weight model, displacing the positive effect of *electricity* in the Wt/A model.

Aside from the order of variables, the only difference between the Uganda raw height model and the Ht/A model is the addition of *succeeding interval 36 months+,* with a negative effect. In the Uganda raw weight model, *husband in government work* appears instead of *mother with secondary education.*

Table 6.20: REGRESSION MODELS OF RAW HEIGHT AND RAW WEIGHT; BURUNDI

RAW HEIGHT (cm)		**B**	**T**	**Sign. T**
Child's age		0.7887	0.698	0.000
Female		1.0932	0.056	0.000
Electricity		2.9176	0.031	0.002
Succeeding interval 24-35mths		-1.4676	-0.037	0.000
Dead sibling		0.7361	0.036	0.000
Succeeding interval <24 mths		1.5287	0.034	0.001
Preceding interval 36 mths +		0.5887	0.027	0.008
No soap in house		-0.7022	-0.027	0.008
Distance to water		-0.0099	-0.023	0.023
Husband secondary education		1.1481	0.022	0.027
Preceding interval < 24mths		-0.7249	-0.025	0.014
Imbo		0.9131	0.023	0.020
Constant		59.2892	1.915	0.000
Adj r2	0.768			
n	1903			

RAW WEIGHT (kg)		**B**	**T**	**Signif. T**
Child's age		0.1683	0.581	0.000
Female		0.4528	0.081	0.000
Piped water		1.1739	0.047	0.000
Imbo		0.3829	0.034	0.001
Succeeding interval <24 mths		0.3540	0.028	0.005
No soap in house		-0.2114	-0.028	0.005
Depressions		0.2379	0.030	0.002
Husband clerical		0.3427	0.026	0.010
Distance to water		-0.0296	-0.024	0.017
Constant		5.6249	0.698	0.000
Adj r2	0.664			
n	1903			

Table 6.21: REGRESSION MODELS OF RAW HEIGHT AND RAW WEIGHT; UGANDA

RAW HEIGHT (cm)		B	T	Sign. T
Child's age2		6.8228	13.277	0.000
South West Province		-1.5075	-0.751	0.000
Succeeding interval < 24 mths		1.8854	0.687	0.000
Urban		1.3467	0.376	0.000
Mother's age		0.0468	0.328	0.000
Female		0.7265	0.429	0.000
Insufficient breastfeeding		2.0217	0.341	0.000
Preceding interval 36 mths +		0.6857	0.3298	0.001
Surface water		-0.5268	-0.323	0.001
Central Province		0.7382	0.336	0.001
Flush toilet		1.6922	0.2802	0.0051
Succeeding interval 36 mths +		-1.1922	-0.280	0.005
Protestant		-0.4870	-2.810	0.005
Distance to water		0.1825	0.226	0.024
Number in household		0.1364	0.362	0.000
Number of children under 5yrs		-0.3308	-0.319	0.001
Constant		44.9180	8.898	0.000
Adj r2	0.878			
n	3145			

RAW WEIGHT (kg)		B	T	Signif.T
Child's age2		1.5907	8.497	0.000
Electricity		0.3884	0.252	0.012
Female		0.4042	0.743	0.000
Succeeding interval < 24 mths		0.7709	0.815	0.000
South West Province		-0.2892	-0.494	0.000
Preceding interval 36 mths +		0.2037	0.314	0.002
Succeeding interval 24-35 mths		0.3525	0.416	0.000
Urban		0.4150	0.316	0.002
Distance to water		0.0765	0.294	0.003
Husband in government work		0.2127	0.216	0.031
Number of children under 5yrs		-0.1241	-0.362	0.000
Number in household		0.0260	2.881	0.004
Constant		2.3978	1.839	0.000
Adj r2	0.802			
n	3145			

Table 6.22: REGRESSION MODELS OF RAW HEIGHT AND RAW WEIGHT; ZIMBABWE

RAW HEIGHT (cm)		B	T	Sign. T
Child's age2		7.5147	13.737	0.000
Urban		1.8163	0.703	0.000
Refrigerator		1.3738	0.389	0.000
Female		0.8345	0.486	0.000
Preceding interval <24 mths		-0.7707	-0.321	0.001
Mother 2y education		0.9385	0.353	0.000
Bulawayo		-1.2381	-0.308	0.002
Husband no education		-0.7500	-0.258	0.010
Resettlement area		-1.4014	-0.279	0.005
Pit latrine		-0.6124	-0.243	0.015
Mother's age		0.0289	0.218	0.030
Fully immunised		-0.3933	-0.221	0.027
Language: English or other		-1.1750	-0.204	0.041
Non-Christian		-0.3606	-0.197	0.050
Constant		44.0320	9.200	0.000
Adj r2	0.901			
n	2358			

WEIGHT/AGE (kg)		B	T	Signif.T
Child's age		0.1659	7.639	0.000
Electricity		0.5621	0.598	0.000
Female		0.5073	0.829	0.000
Husband no education		-0.3805	-0.363	0.000
Refrigerator		0.4910	0.372	0.000
Partially immunised		-0.3357	-0.404	0.000
Husband in service work		-0.2047	-0.275	0.006
Preceding interval <24 mths		-0.2444	-0.286	0.004
Masvingo		0.2431	0.263	0.009
Language English or other		-0.4580	-0.224	0.025
Mother 2y education		0.2509	0.266	0.008
Succeeding Interval 36 mths +		-0.2720	-0.214	0.032
Mother's age		0.0101	2.137	0.033
Constant		6.3896	4.065	0.000
Adj r2	0.789			
n	2358			

In the Zimbabwe raw height model the positive effect of *mother's age* and the negative effect of being *non-Christian* replace the positive effects of *ante-natal care* and *preceding birth interval 36 months+*. The Zimbabwe raw weight model is that most different from the equivalent standardized model. The positive effects of *flush toilet, Blair toilet, succeeding birth interval of 24-35 months* and *speaking Ndebele* were replaced by the positive effects of *electricity* and *female*, while the negative effects of *fully immunized* and a greater *number of children under age five years* were replaced by a stronger negative effect of *partial immunization*. The latter reinforces the argument that the negative effect of *fully immunized* in the age-standardized Z-score model is because the sample of fully immunized children is biased towards older ages.

It should be noted that the sharp differences in the raw weight constants for the three countries are largely an artifact of the different age composition of the three samples, and the inclusion of a squared term in some models. They do not signify real differences in height and weight at birth.

The general similarity of models using Z-scores and those using raw weight and height suggest that either are a reasonable choice. By convention, Z-scores are preferred because they support comparisons of individuals of different ages. However, studies which use models based on Z-scores should emphasize that the small r^2 values are due to the very large contribution of *child's age* to changes in growth attainment over time.

6.4 DISCUSSION

The above comparison of dependent variables as both dichotomous and interval, and both age-standardized and unstandardized, demonstrates the persistence of *child's age, preceding* and *succeeding birth interval* and environmental factors in the models. As expected, *child's age* has the strongest effect in most models, although the effect is generally non-linear. As discussed in Chapter Two, it is well known that weanlings are more vulnerable to the effects of environmental conditions and poor nutrition. It is therefore likely that the impact of these variables differs for children in different age groups. Pelletier and Msukwa (1991: 895) subdivided their sample of Malawi children into two age groups and found the correlates of poor growth attainment were different for children aged 6-23 months compared with children aged 24-59 months. However, it is notable that their ANOVA models explain less than 4 per cent of the variation in Ht/A in either age group.

The probable explanation for this is that their age groups are too broad to capture important differences in the correlates for children of different ages, while age in single months, which was excluded from their models, still explains a substantial proportion of the variation. A better approach would be to use three- or six-month age groups, at least for those under 24 months. However, it is clearly impractical to further subdivide relatively small samples, such as that of Pelletier and Msukwa's Malawi data, or the three DHS data sets used in the present study, for an analysis in which some background variables have many categories. The use of *child's age* as an interval variable across the entire sample of measured children was therefore the only reasonable choice for the present study.

After *child's age*, the variables appearing most consistently in the models are *preceding* and *succeeding birth interval.* In particular, the important contribution of *preceding birth interval < 24 months* to poor growth attainment emerges strongly from the above analysis. *Preceding birth interval* appears in every model except the regression of raw weight in Burundi, usually as a negative effect of a short interval, but sometimes with a positive effect of a long interval. This clearly reflects the deleterious effects of competition from siblings who are close in age.

An outstanding feature of the logistic regression models for Burundi, Uganda and Zimbabwe in Tables 6.14 to 6.16 is the appearance of *province, urban residence* or *strata* in every model except the logistic regression for Zimbabwe Wt/A. In fact, the latter includes *type of toilet facility*, which is itself strongly associated with *province, urban residence* and *strata.*

The next most common variables in the models are other indicators of environmental conditions and crowding, including *source of drinking water, distance to drinking water, electricity, owning a refrigerator, number in household, number of children under age five years* and *having soap in the household.* As would be expected from the literature, *mother's* and *husband's education* and *literacy*, and *husband's occupation* also occur in many of the models, but less consistently than the environmental variables. Other than *child's age*, the only demographic variables in any of the models are *child's sex* and *mother's age*. Although *birth interval,* which appears in all of the models, is obviously a demographic characteristic, in this instance its impact on growth attainment is similar to that of environmental factors, since the presence of a sibling close in age determines a child's access to food and other resources.

These models of the correlates of poor growth attainment are in striking contrast to the models of the correlates of mortality in Chapter Four. Whereas the significant associations with poor growth attainment occur mainly with environmental and socio-economic variables, demographic variables predominate in the mortality models.

Again, it must be emphasized that since growth attainment data were not available for dead children, it was not possible to evaluate the direct association of poor growth attainment with mortality. Even if such data were available, and if they showed that most children who died were wasted and/or underweight at death, they would contribute information only on the association of growth attainment with imminent death. Growth attainment three or six months earlier would almost certainly be better.

The importance of this finding is that it suggests that certain demographic characteristics might be used to distinguish children with an elevated mortality risk. That is, of those children who are moderately stunted and underweight, those who also have short birth intervals, two or more siblings under age five, or a dead sibling should be singled out for special care and monitoring. This is in addition to those from multiple births, who are already widely recognized as having a higher risk of mortality. It is argued that using a combination of demographic characteristics and growth attainment in this way could help to reduce child mortality by channelling resources towards those children who are most at risk.

Another feature of the preceding analysis of growth attainment is the tendency for a cluster of variables to interact to produce favourable conditions for child growth attainment. The similarities between the logistic regression and OLS regression models indicate that these factors operate fairly consistently on growth attainment patterns, whether the focus is on a critical point or across the whole curve. It would appear from this analysis that, provided interactions are fully explored in logistic regression models, it is equally valid to treat height and weight as either dichotomous or interval variables. Using them as interval variables has the added advantage of preserving more detail, while the use of dummy variables emphasizes those categories which are highly significant in the models, since insignificant categories are dropped.

However, relatively small changes in deviance in the logistic regression models (not shown) and low r^2 values in the OLS regression models for Ht/A and Wt/A indicate that a substantial part of the variation in Z-scores is not explained by the variables available in these data sets. There are clearly a number of other factors which have an important impact on growth attainment.

As discussed in Chapter Three, although one strength of DHS surveys is that they are broad ranging and address many topics, considerations of cost and duration of interview mean that the number of questions must be kept to a minimum. As a consequence, many topics are not addressed in sufficient detail to support thorough analysis. Weaning practices and morbidity patterns are two examples. DHS data on infection in the preceding weeks, and foods given to children, lack the precision and detail either to support an in-depth analysis or to allow them to be related meaningfully to growth attainment. Yet these factors are clearly crucial to the explanation of variation in Z-scores.

Other factors related to Z-scores which would require clinical research, in-depth surveys and qualitative approaches to data collection are genetic potential, psychological well-being, household hygiene, access to food, including competition among siblings, and food intake. A survey concerned specifically with growth attainment also should include questions on exercise, personal washing habits, water boiling, food preparation and storage, garbage disposal, household location in relation to environmental features such as swamps and rubbish tips, industrial pollution, drainage and ventilation.

Another crucial variable related to growth attainment is poverty, but questions about income often are omitted from cross-sectional surveys because of their sensitivity and the high probability of inaccurate responses. *Mother's income* is available in the DHS-I surveys for Uganda and Zimbabwe, and *husband's non-agricultural income* for Zimbabwe, but these variables are not necessarily a realistic representation of household control of resources.

Mazur and Saunders (1988: 1029) found in their study of Chitungwiza that, although father's income had the expected negative relationship with growth attainment, mother's income had a curvilinear relationship, with the lowest incidence of stunting observed amongst mothers with incomes less than $20 or above $200 per month. They did not consider household income in their analysis, but household expenditure levels had a varying association with growth attainment (Mazur and Saunders, 1988: 1033). Data which indicated whether the mother was the sole breadwinner in a poor household or a second earner in a wealthy household could produce different results. Similarly, the persistence of variables associated with economic status in all of the models in Tables 6.17 to 6.22 suggests that precise data on household income would have made an important contribution to the r^2 values.

Another important question which could have been asked of all mothers by DHS-I is 'Who cares for the child during the day?'. The nurturing of children demands attention to a range of factors, including feeding, hygiene, health care, protection and social interaction. Neglect of any of these aspects could cause physical or psychological problems, and contribute to growth failure.

In the three data sets considered here, only working mothers in Zimbabwe were asked who cared for the children while they were at work, yet this could be an important factor in growth attainment. Kuate Defo (1992: 333) observed that, although the question of who actually cares for the child is often overlooked, the relationship between mortality and education may be seriously obscured when the educational attainment of only the mother, and not the carer, is considered. African children are often minded by other individuals living in the same household or by neighbours.. In Burundi, women do not customarily take children into the fields when they go to work (K.V.Bailey, personal communication). When small children and infants are separated from their mothers, their feeding patterns and the quality of care they receive could be affected.

Virtually all children aged five and under in the three countries were reported as living with their mothers, with only five in Burundi, 16 in Uganda and nine in Zimbabwe reported as living elsewhere. However, this question does not address the real issue of who actually cares for the child. For example, medical staff in a Kampala hospital spoke of a pattern they have named '*Jaja* (Grandmother) syndrome'. Children cared for by grandmothers are often small, malnourished, and affected by repeated diarrhoea and other infections. This is especially common amongst children of very young or working mothers, who may live with their mother but who are cared for during the day by their grandmother. Ugandan grandmothers are likely to be widowed, and to have limited access to resources and little education. Even if the mother contributes to the cost of the child's food, *jaja*s tend to feed children on cheap, low-protein staples. It can be conjectured that the pattern could be similar for children cared for by older siblings, who might themselves consume the more nourishing food and leave less palatable staples for their juniors. It is interesting that, in Zimbabwe, the highest prevalence of stunting and underweight amongst children of working mothers was for children cared for by an adult relative (Table 6.9). Although there were too few cases to produce a statistically significant result, this might reflect a similar pattern to *jaja* syndrome in Uganda.

Finally, it is notable that the explanatory power of the models for Uganda and Zimbabwe is consistently higher than those for Burundi. This may relate, in part, to the narrower age range of the sample of measured children, but also suggests that different factors are affecting growth attainment in this country.

To summarize, the foregoing analysis contains plausible patterns of the relationship of age with growth attainment, and points to the existence of a cluster of variables, mainly environmental and socio-economic, which provide optimum conditions for growth. However, the explanatory power of the models is limited by the paucity of relevant data in the surveys and by the smallness of the samples, which prevent separation into narrower age groups. More specific and detailed data would be required to fully explore the relationship of socio-economic, demographic, environmental and child-care variables with growth attainment.

There is also evidence of a contrast in the factors associated with mortality and the correlates of poor growth attainment. However, firm conclusions should not be drawn from the preceding analysis because the samples of deaths are biased towards younger ages, while the sample of children with poor growth attainment is biased towards older ages. A large data set with both growth attainment for living children and substantial numbers of deaths at ages 1-4 years would be needed to fully explore differences in correlates. In the absence of such data, an alternative way of comparing the correlates of mortality and poor growth attainment is to determine whether there is clustering of deaths and poor growth attainment within households. This approach will be explored in Chapter Seven.

CHAPTER SEVEN: FAMILY PATTERNS OF MORTALITY, GROWTH ATTAINMENT, LOW BIRTHWEIGHT AND MORBIDITY

7.1 INTRODUCTION

Earlier chapters of this study focused on patterns of mortality and growth attainment among the children of respondents in the three surveys, considering each child as a separate individual. This chapter looks at the same children from a different perspective, that of the family. Its focus is the comparison of the characteristics of children with the same mother. Mothers rather than children now become the unit of analysis so that family patterns can be identified.

Many studies have established the importance of factors which operate at the household level to affect child survival (see, for example, Farah and Preston, 1982; Haines and Avery, 1982; McLean, 1984; Basu, 1989b; Strauss, 1990; Sawyer and Beltrao, 1991; Thomas, Strauss and Henriques, 1991). These include household size, sanitation and income, while other factors, such as child-care practices, may act at the household level, or may affect individual children differently. Caldwell (1979) concluded that the mother's knowledge, autonomy in decision making, and ability to interact with outside agencies, which are influenced by her education, are crucial in determining household child mortality, even though the outer limits may be set by household economic resources and the availability of medical services. Similarly, Basu (1989b: 47) commented:

> *the willingness and ability of the family to prevent child deaths exert an effect quite independent of the income level of the household and its external environment, including the medical services theoretically at its disposal.*

On the other hand, Scrimshaw (1978) and Ballweg and Pagtolun-An (1992) emphasized the contribution of differential care of children to high mortality in households with limited resources.

Relatively few studies focus on the clustering of mortality and poor growth attainment in households. This is due largely to an absence of suitable data. Since only a small proportion of mothers experience more than one child death, a large sample is needed to draw significant conclusions. Similarly, although many more children survive than die, cross-sectional studies of patterns of growth attainment within families also tend to be limited by small numbers of comparable pairs of siblings and censoring problems. A further complication is variation in mean growth attainment at different ages, as shown in Figures 5.10 to 5.15, which prevents simple comparisons of Z-scores.

Beaton et al. (1990: 10) suggested that anthropometric status can be used as a proxy for a household or environmental situation likely to be associated with risk to another child, possibly a sibling yet to be born. This might require the use of different cut-offs from the assessment of individual risk, and other indices in addition to anthropometric measures should be used. They considered that, in the identification of long-term risks to household groups, stunting would be a better indicator than wasting (Beaton et al., 1990: 23).

Several studies point to the existence of families which have an elevated risk of poor child health and mortality. Curtis, Diamond and McDonald (1991) used Brazilian DHS data to identify 'healthy' and 'unhealthy' families. They concluded that the main factors associated with differentials were access to financial resources and breastfeeding. Majumder's (1989: 161) analysis of Bangladesh WFS data showed that a child's mortality risk increased if either of the preceding two siblings was dead. Of the two, however, the death of the adjacent sibling was associated with a smaller increase in risk than the death of the older sibling. This is because the advantage of reduced competition from a sibling close in age partially offset the disadvantage of living in a high risk family. However, death of both preceding siblings was associated with a higher risk than death of the adjacent sibling. Majumder suggested that mothers with repeated child loss could constitute a special group, among whom biological factors affect child survival beyond infancy.

In contrast, Das Gupta (1990) asserted that the tendency for deaths to cluster in families in a rural Punjab community was primarily due to poorer care in some families. Although she acknowledged that biological factors also may play a part, she commented:

> *it was also apparent from extensive participant observation that women who had experienced multiple child deaths were often less resourceful and*

organized in caring for the currently living children and running the household (Das Gupta, 1990: 500).

Curtis, Diamond and McDonald (1991: 1217-1219) discussed problems associated with the analysis of familial mortality experience. Their random-effects logistic regression model for Brazilian DHS data controlled for censoring in several ways. Only families that had a birth in the preceding five years were included in their analysis, and from these were excluded unweaned children, children who died during the neonatal period, and children who were born within one year of the survey. Family effects were represented by including parity as an independent variable. The odds of a family experiencing a death were found to increase dramatically with parity, and if there was one or more short birth interval.

Guang and Rodriguez (1992: 969) suggested that it is incorrect to treat all births as independent observations in a proportional hazards model if siblings share genetic or environmental influences, other than those specifically included as covariates in the analysis. They explored clustering in a Guatemalan data set, using a multi-variate survival model for clustered data that made explicit allowance for correlated observations. From their analysis, they concluded that family-level random effects made only a small difference to the estimation of observed co-variate effects. They commented: 'This result is perversely reassuring, considering that all major studies of infant and child survival to date have ignored clustering effects' (Guang and Rodriguez, 1992: 975).

Their explanation for the small effect was two fold. First, in their Guatemalan data set, they found only a modest degree of inter-cluster association after adjusting for co-variates. Second, they considered that the period from birth to age five is not long enough to show the effect of the large selectivity biases which occur, because members of high-risk clusters are removed from observation at a higher rate than members from low-risk clusters (Guang and Rodriguez, 1992: 975).

Given that key variables related to child-care are available only for children up to age five years, Guang and Rodriguez's controls for correlated observations would be unlikely to yield any better results in DHS data sets. The following section therefore uses simple techniques to look for evidence of clustering of mortality, poor growth attainment and morbidity in the data for Burundi, Uganda and Zimbabwe. Later sections explore techniques for comparing growth attainment of siblings.

7.2 CLUSTERING OF INFANT AND CHILD DEATHS IN FAMILIES

The term *family* is used in a very precise sense in this analysis, to refer to a woman and her children. It is not intended to imply a conventional nuclear or extended family unit. Nor does it equate with *household*, since some households may contain more than one mother and her children. Although some factors in the following analysis clearly operate at the household level, others do not. For example, some children may be affected by the characteristics of their father, while the children of another mother living in the same household may be subject to different influences, because their father is different. Hence, although much of the literature related to family patterns refers to households, it would be unwise to draw conclusions about households from this analysis.

Table 7.1 depicts the child mortality experience of respondents in the three study data sets. The data are presented for five different subsets of respondents: all mothers; all mothers with children aged up to age 60 months; mothers with children aged up to 60 months who were and were not measured; and those with more than one measured child. All child deaths are included, whether or not they occurred in the preceding five years.

The high mortality rate in Uganda, compared with Burundi and Zimbabwe, is clearly reflected in the table. In each of the five groups of mothers, more Ugandans had experienced at least one child death. The figures for Burundi are a little below those for Uganda, and those for Zimbabwe about one-third less than those for Uganda.

An interesting feature of the table is that, among the first four groups, the highest percentage experiencing at least one child death is for those with eligible children who were not measured, while the lowest percentage is for the group with measured children. Even when the group with at least two measured children aged 0-60 months is considered, this still holds true in Burundi and Uganda, although these mothers are exposed to a greater risk of experiencing a death than are mothers with only one child.

Table 7.1: MOTHERS WITH DEAD CHILDREN : BURUNDI, UGANDA AND ZIMBABWE
(per cent)

MOTHERS OF:	All children	Children agec 0-60 months	0-60 months not meas.	0-60 months measured	Measured. & >1 aged 0-60 mnths
BURUNDI	n=2762	n=2355	n=538	n=1817	n=1178
No dead children	54.1	56.9	46.2	60.1	53.5
One or more dead	45.9	43.1	53.8	39.9	46.5
TOTAL	100.0	100.0	100.0	100.0	100.0
Of those with dead children:					
Number dead					
1	53.3	55.8	51.6	57.5	60.1
2	23.3	23.3	21.8	23.9	21.8
3	13.9	12.5	13.8	12.0	12.1
4	5.8	3.0	8.0	4.7	3.8
5	2.1	1.7	2.4	1.2	1.5
6+	1.8	1.3	2.1	0.7	0.7
TOTAL	100.1	97.6	99.7	100.0	100.0
UGANDA	n=3631	n=2921	n=381	n=2541	n=1615
No dead children	50.2	52.9	34.8	55.6	47.6
One or more dead	49.8	47.1	65.2	44.4	52.4
TOTAL	100.0	100.0	100.0	100.0	100.0
Of those with dead children:					
Number dead					
1	58.5	60.8	57.8	61.5	63.6
2	23.6	23.1	24.1	22.9	20.8
3	9.6	9.6	10.8	9.3	9.1
4	4.5	4.3	4.0	4.3	4.7
5	2.1	1.4	2.4	1.2	0.9
6+	1.6	0.8	0.8	0.8	0.8
TOTAL TOTAL	100.0	100.0	100.0	100.0	100.0
ZIMBABWE	n=2948	n=2233	n=438	n=1795	n=888
No dead children	72.1	73.2	71.5	73.6	67.6
One or more dead	27.9	26.8	28.5	26.4	32.4
TOTAL	100.0	100.0	100.0	100.0	100.0
Of those with dead children:					
Number dead					
1	68.4	71.1	69.6	71.5	70.1
2	21.4	20.0	20.8	19.8	20.5
3	7.3	7.0	6.4	7.2	7.3
4	1.8	1.3	2.4	1.1	1.7
5	0.5	0.2	0.0	0.2	0.0
6+	0.6	0.3	0.8	0.2	0.3
TOTAL	100.0	100.0	100.0	100.0	100.0

SOURCE: As for Tables 4.4, 4.5 and 4.6

In the case of Burundi this pattern may be due to the younger age distribution of the children of mothers with measured children, since only those aged 3-36 months were eligible for measurement. Age distribution may also be a partial explanation of the pattern in Uganda and Zimbabwe. As shown in Table 5.4, the main reason for not measuring eligible children in Uganda and Zimbabwe was that they were away when the measurer called. Older children, of course, are more likely to be away. However, it is possible that women who allowed their children to be measured may have been more accustomed to child health monitoring practices, and hence provided better care for their children. This is most likely to be true in Uganda, where there is a difference between the two groups of some 10 per cent in the proportion of children who had died.

Although Table 7.1 shows that more Ugandan mothers had experienced a child death, there is more clustering in Burundi, with a higher percentage of Burundais mothers experiencing multiple deaths. Of mothers who had experienced one or more deaths, the percentage who had lost only one child was least in Burundi and highest in Zimbabwe, in all five subgroups. More Burundais than Ugandan respondents had three, four, or six or more child deaths, with a slightly higher percentage of Ugandans having two or five child deaths. The percentage of all mothers having two deaths is highest in Zimbabwe, but the percentages with more than two deaths are considerably less than in Burundi or Uganda. In all four subgroups of mothers with children under five, there are smaller percentages of Zimbabwean women in each category of multiple deaths.

The first four columns of Table 7.1 are clearly subject to censoring, since those mothers with only one child are not exposed to the risk of having multiple deaths. The fifth column of the table offers a partial control. It is the same as column four, except that mothers with only one child aged 0-60 months have been excluded. It can be seen that in each country around 6 or 7 per cent more mothers in this group have dead children. However, it is interesting that in Burundi and Uganda the main shift in the distribution is an increase in the percentage of single deaths, whereas in Zimbabwe there is a slight increase in the percentage with multiple deaths.

Because of censoring, this table provides only a general indication of clustering. It must be remembered that mothers with one or two measured children could be at the beginning, the middle or the end of their reproductive life. Also they could have widely differing parities, and hence very variable exposure to the risk of child mortality.

An alternative approach is to consider the proportion dead by parity. Table 7.2 presents the proportion of dead children for each parity for all mothers, and of mothers of children aged 0-60. It shows a steady increase with parity in all three countries. The only exception is among parities of 12 or more in Burundi, which can almost certainly be attributed to under-reporting of deaths by older respondents. The smooth increase in the proportions for parities up to 11 and 12+ in Zimbabwe and the sharp increase for parities of 12+ in Uganda suggest that death reporting in these two countries is more comprehensive than in Burundi.

In all countries the proportions are a little lower for mothers with children aged 0-60 months, that is, children born within five years of the survey. This can be attributed in part to the older age and longer exposure to risk of children of higher parities. However, as shown in Chapter Four, there is evidence of a mortality decline in recent years in all three countries. The sharper decline in Burundi than in Uganda is evident in the greater range in the proportions in that country. In Burundi parity 11 has three or four times the proportion dead of parities one and two, whereas in Uganda the difference is only around 20-30 per cent. The magnitude of the differences in Zimbabwe are midway between the two, with the proportions generally much lower for all parities.

As shown in Table 7.3, when only mothers with multiple child deaths are considered, the extent of clustering in this study is comparable to that in Das Gupta's (1990) study of rural Punjab. She found that 12.6 per cent of mothers accounted for 62.2 per cent of child deaths. The ratio of percentage of mothers to percentage of deaths in her study is 1:4.9. This compares with ratios of from 1:3.2 to 1:3.9 for the two groups in Burundi and Uganda, and more than 1:6 in Zimbabwe. It is interesting that these ratios are inversely related to the overall level of mortality in the three African countries, that is, lowest in Zimbabwe and highest in Uganda. The infant mortality rate in rural Punjab of only 62 per thousand is close to that of Zimbabwe. The very high ratios for Zimbabwe seem to reflect clustering among the mothers of the children identified in Table 4.14, for whom having a mother who had not heard of ORT appeared to serve as a proxy for a disadvantaged situation. When clustering was cross-tabulated with knowledge of ORT (not shown), 85 per cent of all mothers considered to have clustering of child deaths had neither used nor heard of ORT. Even among mothers with measured children, who tend to be younger and hence more exposed to health education, 76 per cent of those with clustering did not know about ORT.

Table 7.2: PROPORTION DEAD BY PARITY: ALL MOTHERS AND MOTHERS WITH CHILDREN AGED 0-60 MONTHS, BURUNDI, UGANDA AND ZIMBABWE

BURUNDI

All Mothers				Mothers with children 0-60 mths			
Parity	Total children	Total dead	Proportion dead	Parity	Total children	Total dead	Proportion dead
1	408	43	0.1054	1	343	27	0.0787
2	810	92	0.1136	2	742	73	0.0984
3	1092	162	0.1484	3	963	108	0.1121
4	1588	264	0.1662	4	1460	222	0.1521
5	1720	326	0.1895	5	1480	270	0.1824
6	1698	341	0.2008	6	1404	276	0.1966
7	1435	294	0.2049	7	1113	206	0.1851
8	1112	272	0.2446	8	848	205	0.2417
9	990	238	0.2404	9	738	161	0.2182
10	600	182	0.3033	10	360	96	0.2667
11	352	115	0.3267	11	319	102	0.3197
12+	188	53	0.2819	12+	176	35	0.1989
TOTAL	11993	2382	0.1986	TOTAL	9946	1781	0.1791

UGANDA

All Mothers				Mothers with children 0-60 mths			
Parity	Total children	Total dead	Proportion dead	Parity	Total children	Total dead	Proportion dead
1	652	100	0.1534	1	519	62	0.1195
2	1084	180	0.1661	2	914	144	0.1575
3	1407	229	0.1628	3	1230	188	0.1528
4	1456	282	0.1937	4	1220	224	0.1836
5	1780	310	0.1742	5	1430	246	0.1720
6	1656	327	0.1975	6	1398	260	0.1860
7	2051	373	0.1819	7	1673	299	0.1787
8	1880	366	0.1947	8	1336	257	0.1924
9	1503	289	0.1923	9	981	154	0.1570
10	1330	240	0.1805	10	1000	174	0.1740
11	682	123	0.1804	11	550	96	0.1745
12+	1041	326	0.3132	12+	582	157	0.2698
TOTAL	16522	3145	0.1904	TOTAL	12833	2261	0.1762

ZIMBABWE

All Mothers				Mothers with children 0-60 mths			
Parity	Total children	Total dead	Proportion dead	Parity	Total children	Total dead	Proportion dead
1	565	35	0.0619	1	448	17	0.0379
2	902	48	0.0532	2	710	32	0.0451
3	1215	96	0.0790	3	930	67	0.0720
4	1564	112	0.0716	4	1268	87	0.0686
5	1515	122	0.0805	5	1150	97	0.0843
6	1536	127	0.0827	6	1158	97	0.0838
7	1260	137	0.1087	7	931	112	0.1203
8	1136	127	0.1118	8	808	85	0.1052
9	999	143	0.1431	9	657	98	0.1492
10	780	122	0.1564	10	540	74	0.1370
11	385	59	0.1532	11	198	28	0.1414
12+	393	66	0.1679	12+	263	43	0.1635
TOTAL	12250	1194	0.0975	TOTAL	9061	837	0.0924

SOURCE: As for Tables 4.4, 4.5 and 4.6

Table 7.3: CLUSTERING OF DEATHS AMONGST WOMEN WITH MORE THAN ONE CHILD DEATH: BURUNDI, UGANDA AND ZIMBABWE (per cent)

	BURUNDI			UGANDA			ZIMBABWE		
ALL MOTHERS	%	n	TOTAL	%	n	TOTAL	%	n	TOTAL
Mothers (M)	21.4	592	(2762)	20.7	753	(3641)	8.8	260	(2948)
Deaths (D)	71.5	1692	(2368)	66.6	2110	(3166)	53.4	644	(1206)
Ratio M:D	1:3.5			1:3.2			1:6.01		
MOTHERS WITH MEASURED CHILDREN	%	n	TOTAL	%	n	TOTAL	%	n	TOTAL
Mothers (M)	17.0	308	(1817)	17.1	434	(2541)	7.5	135	(1795)
Deaths (D)	66.3	821	(1238)	62.3	1147	(1841)	48.7	322	(661)
Ratio M:D	1:3.9			1:3.6			1:6.5		

Although the simple comparisons in Tables 7.2. and 7.3 signify some clustering of mortality, and there appear to be 'high-risk' and 'low-risk' mothers in all three study countries, a more sophisticated approach is required to control for differences in exposure to risk. An example is the approach of Trussell and Preston (1982), who used model life tables to estimate the average risk for particular age groups.

David and Zaba (1992: 17) comment that Trussell and Preston's method also can be used to estimate the risk for individual women. The ratio of observed to expected deaths can be calculated, with the expected being the average for each woman's age group and level of mortality. They note that this index is based on the Brass method, which assumes that the risk of dying in childhood varies only with age of child. The Brass view is supported by Hobcraft, McDonald and Rutstein (1985: 369) who found that, in WFS data for 39 countries, there was no evidence that a high maternal age at child birth and high birth orders increased the risk of a child dying. Majumder (1989: 84) reached the same conclusion using Bangladesh WFS data. However, Tables 4.7, 4.8 and 4.9 in the present study indicate that children with mothers aged 45-49 and with birth orders of 11 or more tend to have higher mortality than those with younger mothers or lower birth orders. Birth order remained in the multi-variate model for Burundi (Table 4.20), although in the other models the effects of these variables were offset by those of other variables.

Moreover, although mother's age and parity may have little effect on the survival probability of individual children, there is an obvious association of mother's age with the risk of experiencing clustering of deaths, since it reflects duration of exposure to women aged 15-19 had experienced a child death, compared with almost 60 per cent of those aged 45-49. Curtis, Diamond and McDonald (1991) found that the odds of a family being in the 'high-risk' category increased dramatically with parity.

When devising their own index of clustering, David and Zaba (1992: 17) included controls for marriage duration and parity. This study follows their example and includes controls for duration of exposure to risk and parity, as well as age of child. However, since births may occur outside marriage, age of mother at child's birth was selected, rather than marriage duration.

The first step was to use logistic regression to construct a simple model of the probability of dying for each child, separately for the three countries. The dependent variable was survival status. Only two independent variables were used in this model, mother's age at child's birth and child's age at date of interview (or date of death). These variables reflect the increasing probability of a mother experiencing a death as her parity and her children's duration of exposure to risk increase. A quadratic term, mother's age squared, was added to allow for non-linear patterns.

The model was constructed using the child data files. Thus, the estimated probability of dying is based on all surviving and dead children ever born to all respondents in the survey, not the children of particular mothers. The equation for the model is:

$$p(d) = b_0 + b_1 * ca + b_2 * ma + b_3 * ma^2$$

where d = death, ca = child's age, ma = mother's age, ma^2 = mother's age squared. Table 7.4 shows the estimates for the three countries derived from this model.

Table 7.4: MODEL ESTIMATES OF SURVIVAL PROBABILITIES

BURUNDI

p=-10.13 + .006644 * ca + .3359 * ma -.002411 * ma2

UGANDA

p=-5.797 + .002920*ca + .1239*ma - .0004882 * ma2

ZIMBABWE

p=-10.03 + .006725 * ca + .2613*ma - .0009326 * ma2

These values were then used to calculate each mother's mean probability of experiencing a child death. Using the mother data files, a probability of dying was calculated for each child of each woman, using the estimated values from the model. That is, each child's age, the mother's age at that child's birth and the squared value of the mother's age at child's birth were multiplied by the estimates from the equation and added to the constant. The resulting values were then converting to probabilities using the formula:

$$p = \frac{e^{\text{odds}}}{(1+ e^{\text{odds}})}$$

The next step was to sum the probabilities, and divide the total by the total number of children ever borne, to give a mean probability for each mother. The resulting value, which is each woman's expected probability of experiencing child death, is thus based on her parity, as well as on her age at each birth, and on each child's age at death or at date of interview.

The actual experience of child death of each woman was calculated as:

$$\text{proportion dying} = \frac{\text{(total deaths)}}{\text{(total children ever borne)}}$$

Finally, each mother's observed experience of death was divided by her expected experience of child death, to give an index. An index value greater than one indicated that the observed exceeded the expected. Sixteen, 33 and 21 per cent of all mothers respectively in Burundi, Uganda and Zimbabwe exceeded the expected number of child deaths.

However, further controls were necessary to identify true cases of clustering. Using the above method, mothers who have borne only one or two children, of whom one has died, have a high index value, yet could not reasonably be considered to have clustering of deaths. Thus, to avoid distortion from high index values at low parities, mothers with clustered deaths were defined as having both an index value greater than one and also more than one child death.

Table 7.5: CLUSTERING OF CHILD DEATHS AMONGST MOTHERS: BURUNDI, UGANDA AND ZIMBABWE (per cent)

ALL MOTHERS

	% with any deaths	% clustered	n mothers
BURUNDI	45.9	5.8	2529
UGANDA	48.1	14.7	3345
ZIMBABWE	27.9	6.0	2764

MOTHERS WITH MEASURED CHILDREN

	% with any deaths	% clustered	n mothers
BURUNDI	39.9	5.4	1600
UGANDA	42.8	13.4	2329
ZIMBABWE	26.4	5.9	1692

Table 7.5 shows that between 6 and 15 per cent of all mothers, and all mothers with measured children in the three countries had clustering of deaths, as defined by the two criteria. As there is a bias towards younger ages among mothers with measured children, the slightly lower percentage with clustering could reflect improved access to child-health facilities in recent years, although the difference is too small to draw a firm conclusion. It is interesting that clustering is most apparent in Uganda, when controls are introduced for exposure to risk and age of child, although this country appeared to have less clustering in Tables 7.1 and 7.3.

Figures 7.1, 7.2 and 7.3 plot the distribution of clustering by mother's age, for all mothers and mothers with young children. It can be seen that in all three countries clustering occurs most frequently among women in their late twenties to late thirties, but tails off among women in their forties. Since their parity tends to be high, and hence their exposure to risk is high, the expected number of deaths for older mothers also is high; so fewer exceed it. On the other hand, both the expected experience of

Figure 7.1: DISTRIBUTION OF MOTHERS WITH CLUSTERED DEATHS: BURUNDI

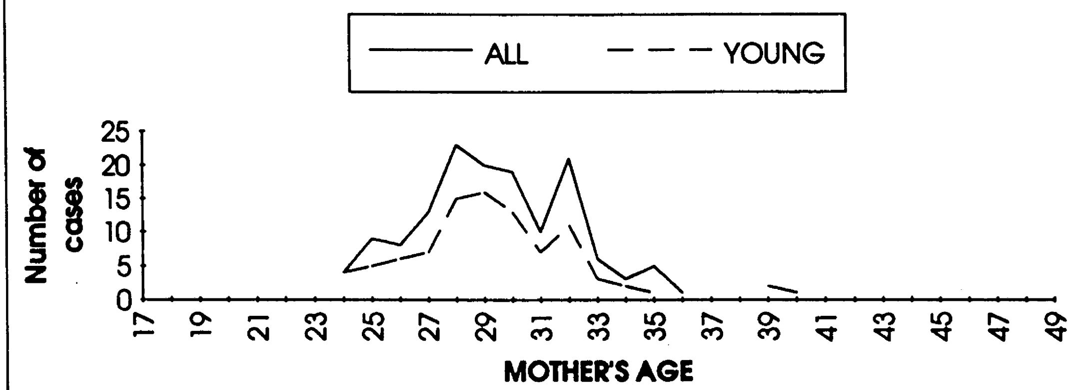


Figure 7.2: AGE DISTRIBUTION OF MOTHERS WITH CLUSTERED DEATHS: UGANDA

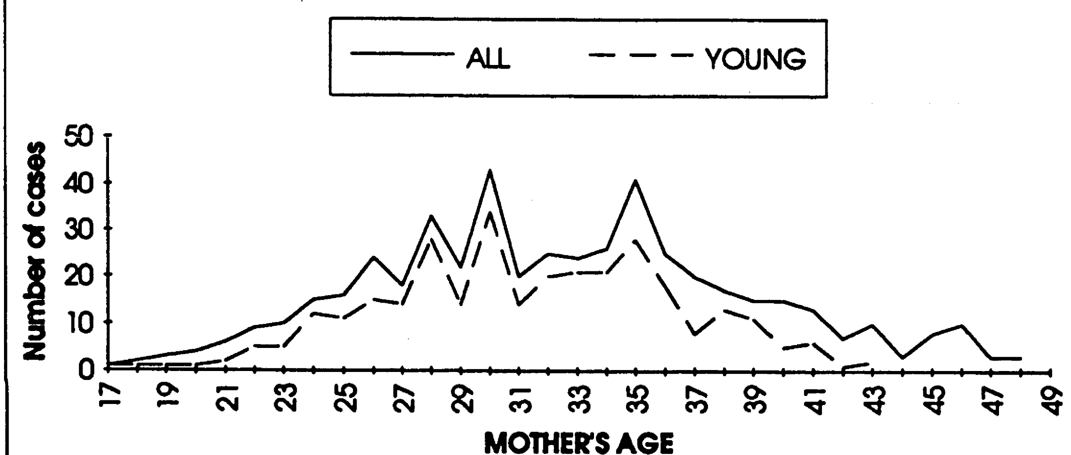
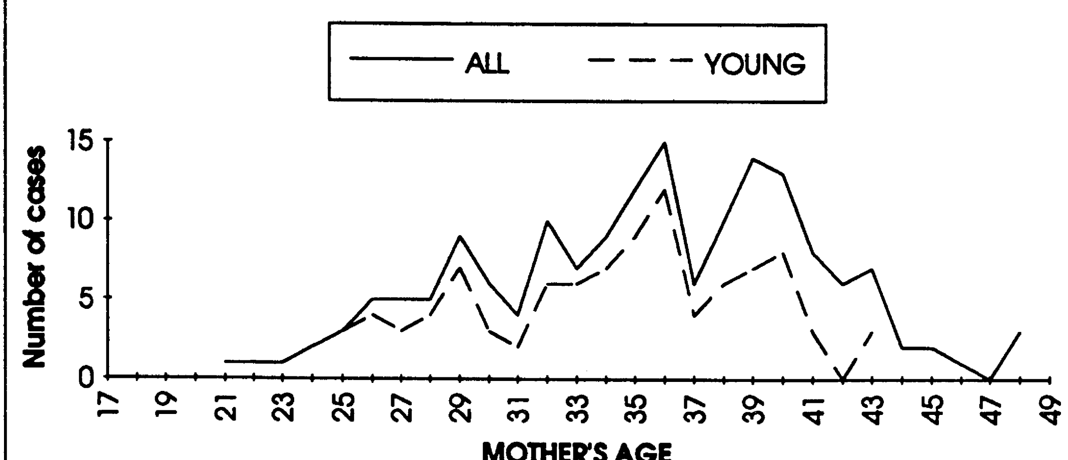


Figure 7.3: AGE DISTRIBUTION OF MOTHERS WITH CLUSTERED DEATHS: ZIMBABWE



Source: As for Tables 4.4, 4.5 and 4.6.

death and, in most cases, the actual experience of death is low for very young women. Hence clustering is most likely to manifest among women in their twenties and thirties.

The following section explores the clustering of mortality with other characteristics and examines the correlates of the clustering evident in Table 7.5.

7.3 CLUSTERING OF POOR GROWTH ATTAINMENT, LOW BIRTHWEIGHT, MORBIDITY AND MORTALITY

The limitations of cross-sectional anthropometry as a predictor of mortality have been discussed in earlier chapters. It was shown that the significant characteristics of the large percentage of surviving children who were stunted or underweight tends to differ from those of children who died; so these conditions alone do not necessarily imply an elevated risk of mortality. On the other hand, only a small proportion of children in the surveys were found to be wasted. It was noted that there is a propensity for wasted children to be censored by deaths, since wasting is a condition known to carry a greater risk of mortality. It could therefore be expected that wasting would tend to cluster with mortality, whereas there would be a weaker association of mortality with stunting and underweight. Similarly, low birthweight, another characteristic carrying a greater risk of death, also would be expected to occur more frequently among children whose mothers had already experienced a child death.

This section looks at families which reported more than one of these characteristics. That is, families where different combinations of poor growth attainment, low birthweight and mortality occurred. The objective is to determine whether these characteristics appear to cluster in families, or whether there are no strong patterns of association.

Table 7.6 shows the percentage of mothers with one or more children who are more than 2 SDs below the reference median for either Ht/A, Wt/A or Wt/Ht. Also shown is the percentage with one or more children who had suffered diarrhoea, either in the 24 hours or the two weeks preceding the interview, since diarrhoea is often a cause of short-term weight loss, which could manifest as underweight. It should be noted that, since the unit of analysis in this chapter is mothers rather than children as individuals, the percentages in various categories differ from those reported in earlier chapters.

Table 7.6: MOTHERS WITH STUNTED, UNDERWEIGHT, WASTED AND SICK CHILDREN: BURUNDI, UGANDA AND ZIMBABWE (per cent)

	BURUNDI	UGANDA	ZIMBABWE
	Per Cent n=1817	Per Cent n=2541	Per Cent n=1795
Stunted Children			
0	51.3	47.7	66.0
1	46.3	39.3	28.5
2	2.4	12.0	5.2
3		0.9	0.3
4		0.1	
TOTAL	100.0	100.0	100.0
Underweight Children			
0	60.4	70.5	85.2
1	38.7	24.6	13.8
2	1.0	4.7	0.9
3		0.2	0.1
TOTAL	100.1	100.0	100.0
Wasted Children			
0	93.7	97.3	98.2
1	6.2	2.6	1.8
2	0.1	0.1	
TOTAL	100.0	100.0	100.0
Children with Diarrhoea			
0	73.1	63.3	71.3
1	24.4	32.9	26.4
2	2.5	3.4	2.4
3		0.3	
TOTAL	100.0	99.9	100.1

SOURCE: As for Tables 4.4,4.5 and 4.6.

Although information on diarrhoea was available for all Burundais children up to age 60 months, those aged 37-60 months are excluded from this table, as only children aged 3-36 months were measured. In view of this, it is striking that the percentage of mothers with one or more wasted children is much higher in Burundi than in either Uganda or Zimbabwe, that is, 6.3 compared with 2.7 and 1.8 per cent.

More mothers in Uganda have stunted children than in either Burundi or Zimbabwe, with 13 per cent having two or more. On the other hand, underweight was more common in Burundi. Since the percentage with children who had suffered diarrhoea in the preceding two weeks was greater in Uganda than in Burundi, the high incidence of underweight in Burundi does not appear to be caused solely by recent infection.

As with the analysis of mortality-clustering above, a limitation of Table 7.6 is that some of the mothers have only one measured child, and so are not exposed to the risk of multiple incidences of stunting, underweight, wasting or diarrhoea. The narrower age range of measured children in Burundi than in Uganda and Zimbabwe must be considered the major factor contributing to a lower occurrence of multiple incidence in that country. Nonetheless, the large percentage of Burundais women with one stunted child suggests that a comparable sample of children could have yielded a higher percentage of mothers with more than one stunted child than in Uganda.

The very small percentage of women with more than one wasted child in all three countries must be attributed to the seriousness of this condition, which carries a high risk of mortality. This is explored further in Table 7.7, which looks at the percentage of mothers whose families suffered various combinations of stunting, underweight, wasting, diarrhoea, death and, in the case of Zimbabwe, low birthweight. The first column for each country looks at all mothers with measured children, while the second column provides a partial control for censoring by considering only mothers with at least two children aged 0-60 months.

The upper section of the table shows the overall percentage of mothers whose children manifest any of the conditions. It can be seen that having a stunted child is by far the most prevalent characteristic in all three countries, followed by having a dead child. As expected, in Uganda and Zimbabwe the percentages are consistently higher for mothers with at least two children, who have more exposure to risk than those with only one child. That this is not true for the growth attainment variables for Burundi must be attributed to the narrower age range of measured children in that country.

The remainder of the table looks at combinations of these characteristics. A striking feature is that, although the upper panel of the table shows that having a dead child is more common than having an underweight child, the most common combination is stunting and underweight. In almost all cases, in all three countries, the same child is

Table 7.7: CLUSTERING OF STUNTING, UNDERWEIGHT, WASTING, DIARRHOEA, DEATH AND LOW BIRTHWEIGHT AMONGST MOTHERS WITH MEASURED CHILDREN AGED 5 YEARS AND UNDER (per cent)

	BURUNDI		UGANDA		ZIMBABWE	
	All	>1 child 0-60 mth	All	>1 child 0-60 mth	All	>1child 0-60 mth
	n=1817	n=1178	n=2541	n=1615	n=1795	n=888
Characteristic:						
Stunting	48.7	48.0	52.3	57.9	36.0	41.9
Underweight	39.7	39.2	29.5	33.6	14.8	18.3
Wasting	6.2	5.8	2.7	3.5	1.8	2.3
Diarrhoea	26.9	28.4	36.7	39.5	28.7	33.2
Death	39.9	46.5	44.4	52.4	26.4	32.4
Stunting+Underweight	32.7	33.1	27.9	32.3	12.6	15.9
(Same child)	32.7	33.1	27.4	31.6	12.3	15.3
Stunting + Wasting	3.0	3.0	2.1	3.0	0.9	1.0
Stunting + Death	18.3	20.9	23.7	29.1	10.4	13.9
Underweight + Wasting	4.8	4.4	2.3	3.1	1.4	1.9
Underweight + Death	16.3	18.5	13.8	17.0	5.0	6.8
Wasting + Death	2.9	3.0	1.6	2.1	0.6	0.8
Stunting+ Underweight+Death	12.8	14.9	13.2	16.5	4.4	5.7
Stunting+Underweight + Wasting	2.9	2.9	2.0	2.8	0.9	1.0
Stunting+Underweight + Wasting +Death	1.1	1.3	1.2	1.8	0.0	0.3
Diarrhoea+ Stunting	13.3	12.7	20.4	23.7	11.8	15.8
Diarrhoea + Underweight	11.1	10.8	11.9	14.3	5.6	7.4
Diarrhoea + Wasting	2.2	2.1	1.1	1.5	0.4	0.5
Diarrhoea + Death	11.1	14.0	16.5	20.7	7.3	9.7
Diarrhoea + Stunting + Underweight	9.0	9.0	11.2	13.7	5.0	6.9
Diarrhoea + Stunting + Wasting	1.1	1.0	0.9	1.3	0.2	0.2
Diarrhoea + Underweight + Wasting	1.6	1.4	1.1	1.5	0.4	0.5
Diarrhoea + Stunting + Underweight + Wasting	1.1	1.0	0.9	1.3	0.0	0.2
Diarrhoea + Stunting + Underweight + Death	3.1	3.4	5.1	6.7	1.7	2.4
Diarrhoea + Stunting + Underweight + Wasting + Death	0.4	0.4	0.5	0.7	0.1	0.1
					n=867	n=543
Low birthweight (Lbw)					10.0	8.3
Stunting + Lbw					2.9	4.3
Underweight + Lbw					1.2	1.7
Wasting + Lbw					0.1	0.2
Diarrhoea + Lbw					2.0	2.1
Death + Lbw					2.0	3.0
Stunting + Death+ Lbw					1.1	1.7
Death + Underweight + Lbw					0.3	0.3
Death + Stunting + Underweight + Lbw					0.3	0.3
Death + Stunting + Underweight + Wasting + Lbw					0.0	0.0

SOURCE: As for Tables 4.4, 4.5 and 4.6.

both stunted and underweight. In contrast, among those with at least two children, only a little over half of Ugandan mothers with a dead child also have stunted child. The comparable figures are somewhat less than half for Burundi and Zimbabwe. Of those with at least two children, around one-third of Burundais and Ugandan mothers who have a dead child, and less than a quarter of Zimbabweans, also have an underweight child. The proportions of stunting and underweight among mothers with two children are generally not very different from the proportions in the entire sample of mothers with measured children.

Two-thirds of Ugandan mothers who have a wasted child also have a dead child. In Burundi the narrower age range of measured children has shortened the duration of their exposure to the risk of having a dead sibling; so even though the percentage of mothers with a wasted child is more than double that in Uganda, only about half also have a dead child. It is likely that the pattern would be similar to that for Uganda had measurements been collected for children up to age 60 months. In Zimbabwe, however, only one-third of mothers with a wasted child also have a dead child.

It is interesting that, even though occurrences of both stunting and underweight involved the same child in most cases, there is a difference of 4 per cent between *underweight + death*, and *stunting + underweight + death*, in Burundi, although the percentages are closer in Uganda and Zimbabwe. Similarly, there is a considerable difference between *stunting + death*, and *stunting + underweight + death*, in all three countries. That is, some of the families which have only a stunted child may also have a dead child, while the combination of stunting and underweight is not always associated with death.

The patterns in Table 7.7 support the evidence presented in previous chapters, that cross-sectional observations of stunting and underweight are not good predictors of death, and that surviving children of mothers who have experienced a child death do not appear to have a greater risk of stunting and wasting. Without anthropometric measurements for all dead children, it is impossible to draw conclusions about the extent of censoring of the data sets due to deaths of wasted children. However, it can be stated that wasting shows a slight tendency to cluster with deaths in the two countries with higher mortality, but not in Zimbabwe where the level of mortality is lower.

Birthweight data are available for only a little over half of the sample of Zimbabwean children under age 60 months, of whom only 10 per cent of children weighed 2500 grams or less at birth. The extent of clustering of low birthweight with other conditions is therefore small. The strongest association is between stunting and low birthweight among mothers with two or more measured children, but still the proportions are little different from those for the whole sample of mothers with measured children. Thus, a much larger sample of birthweights would be needed to establish significant patterns of association.

Table 7.7 also shows clustering of diarrhoea with poor growth attainment. Since repeated episodes of diarrhoea are one cause of malnutrition and poor growth attainment (see for example, Chen and Scrimshaw, 1983; Rowland and Rowland, 1985; Tomkins and Watson, 1989), it was expected that some clustering would be evident, particularly with underweight. However, the proportions of those with stunted, underweight and dead children, who also had children with diarrhoea, are roughly the same as the proportion of the whole sample of mothers with measured children who had children with diarrhoea. A slightly higher proportion of mothers with wasted children also had children with diarrhoea.

The general lack of association of diarrhoea with other conditions could be due in part to the DHS reliance on maternal reporting of infections. It is well known that the perception of diarrhoea varies between mothers, when clinical assessment is not available. As noted above, mothers whose children are frequently affected are more likely to regard a mild degree of diarrhoea as normal, whereas mothers of children who are usually healthy are more likely to report all episodes. There is, therefore, a tendency for mothers of children in poor health, who are also likely to be those with poor growth attainment, to under-report diarrhoea.

Cross-sectional data sets are unsuitable for detailed analysis of the association of poor growth attainment and infection, which requires precise linking of cause and effect over a longer period of time. Moreover, the infection data in DHS data sets cannot be considered reliable because of the absence of clinical diagnosis. Nonetheless, it is interesting to consider clustering of episodes of infection within families, since each respondent should have a uniform perception of illness among her own children, even if perceptions differ between respondents.

Aaby (1990: 827) cited historical evidence from industrial Europe, and his own research in Africa, which demonstrated that measles episodes tend to be more severe when several individuals in the same household are affected concurrently. He suggested that this is because the absorbed dose of measles virus is greater when exposure is intensive (Aaby, 1990: 830). Although this does not necessarily apply to other infections, clustering of episodes of the same disease and of different diseases with some families could point to a less unhealthy environment.

Table 7.8 shows the number of reported episodes of diarrhoea, fever and respiratory infections, for all mothers with measured children and those with more than one measured child. As discussed above, these reports are based on maternal recall, with reference periods of 24 hours and 2-14 days for diarrhoea, and four weeks for fever and respiratory problems. Except in the case of diarrhoea, DHS asked for reports of symptoms only; so it is not possible to determine the exact infection suffered by the child. The specific respiratory conditions mentioned to respondents were cough and difficult breathing.

The table shows that, in general, Zimbabwe has the lowest prevalence of all infections, while Uganda has the highest prevalence of diarrhoea in all groups and the highest prevalence of fever. Burundi has the highest prevalence of respiratory problems, with 50 per cent of all mothers and 55 per cent of mothers of measured children reporting a respiratory infection. These differences must be partly attributed to environmental conditions and seasonal variations in disease patterns. As noted in the UDHS report (UMOH & IRD, 1989: 67), malaria is endemic in Uganda, and most fevers can be attributed to malaria. Malaria is also endemic in parts of Burundi, while the cooler, mountainous regions of this country have a higher prevalence of respiratory problems. Zimbabwe, on the other hand, has a generally drier climate, where malaria and respiratory problems are less common.

Multiple cases of infection were most common for fever in Uganda, where 30 per cent of mothers with more than one measured child reported two or more episodes in the reference period. However, the comparable figures were only around 3 per cent for Burundi and Zimbabwe. In all three countries, clustering is most common for respiratory problems, although the percentage is less than for fever in Uganda. In Burundi, 23 per cent of mothers with more than one more measured child reported two or more episodes during the reference period. In Uganda and Zimbabwe it was only 15

Table 7.8: MOTHERS WITH SICK CHILDREN: BURUNDI, UGANDA AND ZIMBABWE (per cent)

	BURUNDI		UGANDA		ZIMBABWE	
	Any	2+	Any	2+	Any	2+
	%	%	%	%	%	%
Number of Children With:	n=1817	n=178	n=2541	n=1150	n=1795	n=633
Diarrhoea in last 24 hours						
0	87.5	86.4	77.9	74.4	87.5	84.6
1	11.8	10.8	20.7	22.6	11.3	12.6
2	0.7	2.7	1.3	2.8	1.2	2.8
3			0.1	0.2		
Diarrhoea in last 2-14 days						
0	85.2	84.2	83.9	80.2	83.8	81.6
1	13.9	14.2	15.3	18.0	15.3	16.0
2	0.9	1.4	0.8	1.8	0.9	2.4
Diarrhoea in both time periods						
0	99.3	99.2	98.5	96.6	99.8	95.5
1	0.7	0.8	1.5	3.4	0.2	0.5
Fever in last 4 weeks						
0	88.8	83.7	48.5	43.2	91.2	88.8
1	9.6	12.8	36.8	26.6	7.6	8.4
2	1.6	2.7	13.1	26.9	1.1	2.6
3		0.8	1.5	3.1	0.1	0.2
4			0.1	0.2		
Respiratory problems in past 4 weeks						
0	50.0	45.4	71.1	64.8	78.8	76.0
1	37.3	31.6	21.9	20.4	17.8	15.7
2	11.9	19.6	6.2	13.0	3.3	8.1
3	0.8	3.4	0.8	1.8	0.1	0.2

SOURCE: As for Tables 4.4, 4.5 and 4.6.

per cent and 8 per cent respectively. Other than this, only 3 to 4 per cent of mothers in either group reported more than one child with any of the conditions.

The percentages of mothers whose children suffered from more than one condition in the reference period are shown in Table 7.9. It must be noted that this table relates to whether or not more than one type of infection occurred in the household, regardless of whether a single child suffered from more than one illness. Diarrhoea in this table is computed by summing occurrences in both reference periods.

The most frequently occurring combinations are fever and respiratory problems, and fever and diarrhoea in Uganda, which can be attributed to the high prevalence of malaria in that country. It is interesting that the combination of diarrhoea and

Table 7.9: MOTHERS WHOSE CHILDREN HAD MORE THAN ONE INFECTION DURING THE REFERENCE PERIOD BURUNDI, UGANDA AND ZIMBABWE (per cent)

Number of Children With:	BURUNDI Any % n=1817	BURUNDI 2+ % n=178	UGANDA Any % n=2541	UGANDA 2+ % n=1150	ZIMBABWE Any % n=1795	ZIMBABWE 2+ % n=633
Fever + Respiratory						
0	95.8	88.3	81.3	76.0	96.0	93.4
1	7.2	11.7	18.7	24.0	4.0	6.6
Fever + Diarrhoea						
0	95.0	91.6	76.8	71.1	97.2	95.6
1	5.0	8.4	23.2	28.9	2.8	4.4
Diarrhoea + Respiratory						
0	84.1	82.8	86.7	81.4	92.8	91.3
1	15.9	17.2	13.3	18.6	7.2	8.7
Fever + Diarrhoea + Respiratory						
0	96.6	93.9	90.3	86.0	98.6	97.3
1	3.4	6.1	9.7	14.0	1.4	2.7

SOURCE: As for Table 4.4, 4.5 and 4.6.

respiratory infections is more common in Uganda than in Burundi, even though respiratory disease, but not diarrhoea, is more common in Burundi. Further evidence of the poorer health status of children in Uganda, relative to Burundi and Zimbabwe, is that 14 per cent of Ugandan mothers with more than one measured child reported fever, diarrhoea and respiratory infections among their children in the reference period. Combinations of diseases occurred in only a small percentage of families in Zimbabwe, with diarrhoea and respiratory problems the most frequent.

7.4 MULTI-VARIATE ANALYSIS OF CLUSTERING

As a final step in this exploration of clustering, logistic regression was used to determine whether clustering of deaths had a significant association with poor growth attainment and morbidity, and to examine the characteristics of mothers who experienced clustering of deaths. The dichotomous dependent variable is *whether or not the mother had experienced clustering of deaths*. Clustering is defined as observed deaths exceeding expected, plus having more than one dead child, as shown in Table 7.5.

The independent variables were recoded as in Chapters Four and Six, with the category with the largest number of cases used as the reference category. Two separate models were constructed for each country: one for all mothers, and one for mothers who had measured children. Additional variables added to the model for mothers of measured children were *risk of stunting, risk of underweight, risk of wasting* and *risk of sickness.*

It will be noted that, in each of the final models, *mother's age* substantially increases the odds of experiencing clustering relative to the base category, while the squared form of *mother's age* resulted in a small reduction. This reflects the strong, but non-linear relationship of mother's age with clustering depicted in Figures 7.1, 7.2 and 7.3. *Mother's age* and *mother's age squared* should, therefore, be considered as a single variable which shows a positive association with the odds of experiencing clustering of deaths.

Table 7.10: RELATIVE ODDS OF CLUSTERED MORTALITY: BURUNDI

ALL MOTHERS

	Estimate	S.E.	Odds
Base	-32.9800	4.6630	1.00
Mother's age2	-0.0399	0.0052	0.96
Number in household	-0.5538	0.0665	0.57
Mother's age	2.2280	0.3124	9.28

MOTHERS WITH MEASURED CHILDREN

	Estimate	S.E.	Odds
Base	0.4868	0.4613	1.00
Number in household	-0.5163	0.0862	0.60
Children ever borne	1.1320	0.1104	3.10
Mother's age2	-0.0061	0.0008	0.99

SOURCE: As for Table 4.4.

Tables 7.10, 7.11 and 7.12 show that a higher number of children ever borne substantially increased the odds for mothers with measured children in Burundi, and both mothers with and without measured children in Uganda and Zimbabwe. In Uganda, *husband's education* figures in the models for both groups, with *secondary education* reducing the odds of clustering and *no education* increasing them. *Mother's education* acts in the same way in the Ugandan model for mothers with measured children, and the model for all mothers in Zimbabwe. The absence of *mother's*

Table 7.11: RELATIVE ODDS OF CLUSTERED MORTALITY: UGANDA

ALL MOTHERS

	Estimate	S.E.	Odds
Base	-12.0600	1.0880	1.00
Children ever borne	0.4453	0.0322	1.56
Mother's age	0.6953	0.0682	2.00
Husband's education			
Primary			1.00
Secondary	-0.5999	0.1437	0.55
None	0.1466	0.0813	1.16
Mother's age2	-0.0120	0.0010	0.99
No. children under 5yrs	-0.3641	0.0645	0.69
No. in household	-0.1299	0.0255	0.88

MOTHERS WITH MEASURED CHILDREN

	Estimate	S.E.	Odds
Base	-17.9100	1.9050	1.00
Children ever borne	0.5612	0.0491	1.75
Mother's age	1.0630	0.1227	2.90
Mother's age2	-0.0190	0.0019	0.98
Mother's education			
Primary			1.00
Secondary	-0.4608	0.3599	0.63
None	0.2858	0.1490	1.33
Husband's education			
Primary			1.00
Secondary	-0.6569	0.2144	0.52
None	0.1705	0.1716	1.19
No. in household	-0.5754	0.0797	0.56

SOURCE: As for Table 4.5.

education from the Zimbabwe model for mothers with measured children probably reflects the higher and more uniform standard of health care in that country in recent years.

In Burundi a larger household reduces the odds of clustering for all mothers, and in Uganda it reduces the odds for both groups. This is consistent with higher survival probabilities for larger households in Burundi and Uganda, as shown in Figures 4.8

Table 7.12: RELATIVE ODDS OF CLUSTERED MORTALITY: ZIMBABWE

ALL MOTHERS

	Estimate	S.E.	Odds
Base	-17.6700	2.4840	1.00
Children ever borne	0.4773	0.0484	1.61
Mother's education			
Primary			1.00
Secondary	-0.5793	0.4236	0.56
None	0.5413	0.1959	1.72
Type of toilet facility			
None			1.00
Flush	-0.5528	0.2771	0.58
Blair	0.3101	0.2275	1.36
Pit, other	0.3802	0.2410	1.46
Mother's age	0.8147	0.1422	2.26
Mother's age2	-0.0129	0.0020	0.99

MOTHERS WITH MEASURED CHILDREN

	Estimate	S.E.	Odds
Base	-18.0700	3.5940	1.00
Children ever borne	0.7512	0.0792	2.12
Mother's age	0.8444	0.2147	2.33
Mother's age2	-0.0151	0.0031	0.99

SOURCE: Table 4.6.

and 4.15. The only other environmental variable in the models is *type of toilet facility* in Zimbabwe, where a flush toilet substantially reduces the odds of clustering. Interestingly, the Blair toilet, customised for Zimbabwean conditions, increases, rather than reduces, the odds. This compares with Table 6.9 where a Blair toilet was shown to be associated with nearly as much stunting and underweight as a pit latrine or no facility at all. It is possible, however, that this is partially a reflection of the harsh conditions in those areas where the waterless Blair toilet is used. The group of very disadvantaged Zimbabwean mothers referred to above and in Chapters Four and Six can be identified in these models as those women with no education, who have substantially higher odds of clustering.

Having stunted, underweight or *wasted children* was not significantly associated with clustering of mortality in any of the models for mothers with measured children. Moreover, there was no significant association of *diarrhoea in the reference period* with the odds of clustering. In most cases these variables were insignificant even when fitted to the model one at a time, so it cannot be argued that their effects have been cancelled out by other variables. It is particularly surprising that wasting did not figure as significant, since it is often a precursor to death, and there was some evidence of clustering of death and wasting in the bi-variate analysis in Table 7.7. Since other studies, such as Gubhaju (1985) and Majumder (1990) have reported that children with a dead preceding sibling have substantially higher risks of mortality, a significant association of wasting and clustering was expected. However, it must be remembered that the prevalence of wasting is very low in these data sets, and wasted children may not survive for long. Thus, the snapshot provided by these cross-sectional data sets may not capture the association of wasting with death. Larger samples with more cases of wasting might have shown significant associations.

7.5 SIBLING GROWTH ATTAINMENT PATTERNS

The exploration of factors associated with differential growth attainment of siblings is important in the identification of cases with an elevated risk of poor growth attainment. Health personnel who provide treatment or monitor growth often see only one child at a time, although there may be several in a family. The identification of family characteristics which might indicate elevated risks for that child's siblings is therefore important. Table 7.6 confirmed that some families had more than one child with poor growth attainment, especially in Uganda.

Mueller (1984) pointed out that environment can have a substantial effect on the growth of homozygotic siblings, even before birth. He cited a Taiwanese study which showed that adding a calorie and protein supplement to maternal diets during a second pregnancy dramatically improved growth attainment at birth of the second infant compared with the first. Also he referred to several studies which demonstrate that siblings who are far apart in age tend to have diminished similarities in growth attainment over time, because the effect of environmental differences tends to be greater (Mueller, 1984: 57).

This section has two objectives. The first is to test a method of comparing growth attainment of siblings. The second is to determine whether particular characteristics are significantly associated with poorer growth attainment of the second-youngest child, relative to the youngest.

The DHS-I cross-sectional data on growth attainment for the three study countries does not support direct comparison of siblings. This is primarily because of the pattern of deteriorating mean growth attainment as age increases. As discussed in Chapter Five and depicted in Tables 5.10 to 5.15, all three countries exhibit a marked deterioration in mean Z-scores with age, with different patterns for males and females. As pointed out, this pattern appears to be due to socio-economic and environmental factors rather than to intrinsic ethnic differences. Nonetheless, it is necessary to control for these factors if a comparison of sibling growth attainment is to be meaningful at the household level.

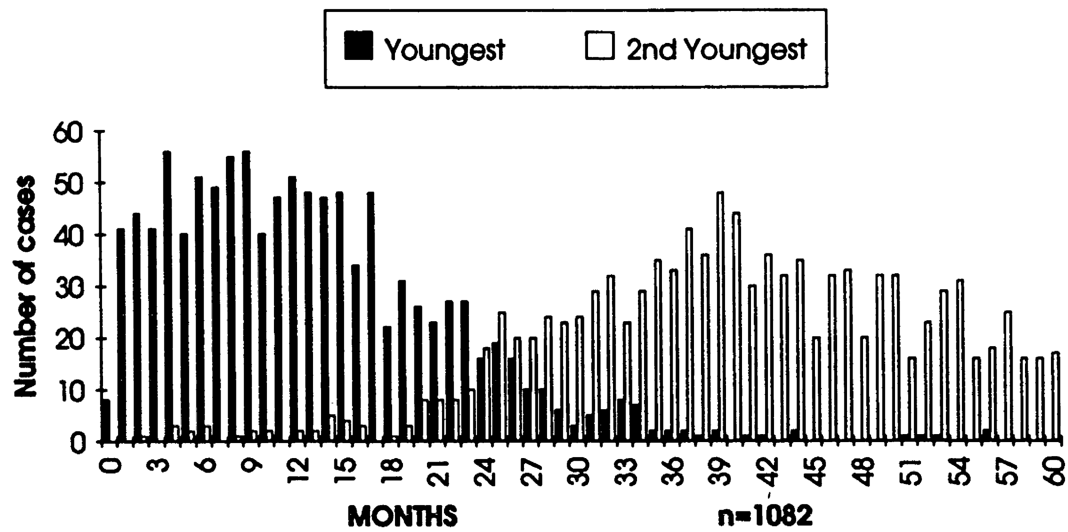
The simplest and most direct method of comparing sibling patterns is to plot the mean Z-scores for each age interval, separately for each birth order. For example, the means for all youngest children might be compared with those for all second-youngest children. This can be done for a relatively small sample when longitudinal data are available. However, where only cross-sectional observations are available, a much larger sample is required. This is because the number of both older and younger siblings at each age must be sufficient to produce representative means.

Because the Burundi data set includes anthropometric data only for children aged three years and under, only 164 mothers in the Burundi data set had at least two measured singletons[1]. Although there were 1002 mothers with two measured singletons in Uganda and 577 in Zimbabwe, this was still insufficient to derive comparable data for each group of siblings separately by sex. As shown in Figure 7.4, even for Uganda the numbers of youngest children in the older age categories and second-youngest children in the younger age categories are so small that the means are too variable for valid comparison.

An alternative approach to the comparison of siblings using cross-sectional data is therefore explored in this study. This approach uses the mean Z-scores for all measured children in each age group in each country, separately by sex, as a basis for

1 Multiple births cannot be included in comparisons of siblings because, as shown in Figures 5.4 to 5.7, they tend to be a-typical in their growth patterns.

Figure 7.4: AGE DISTRIBUTION OF MEASURED SIBLINGS: UGANDA

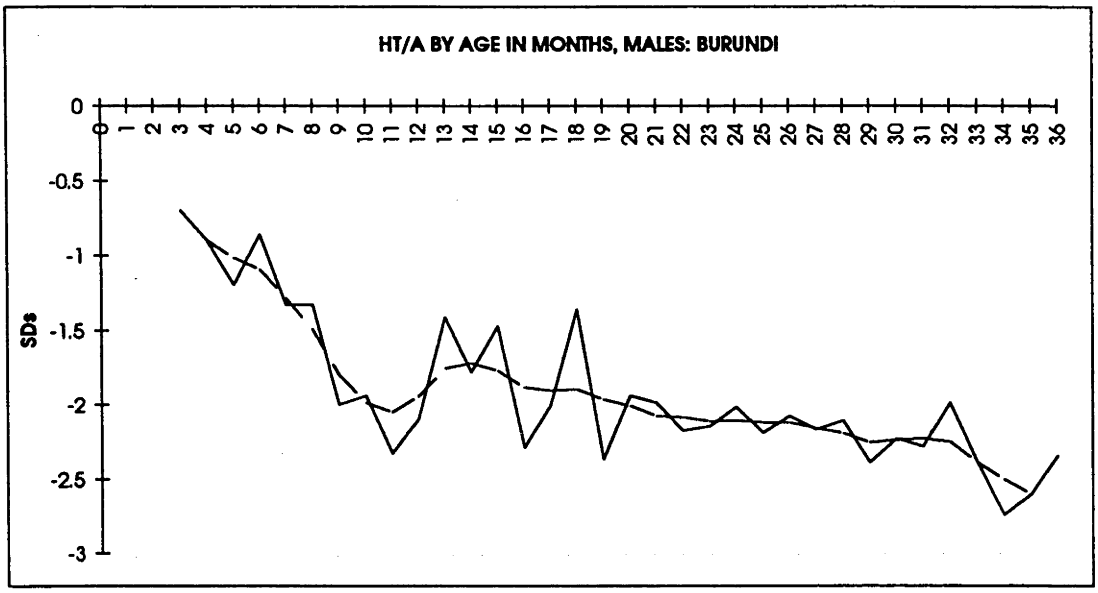


calculating a country-specific reference, that is, the means depicted in Tables 5.10 to 5.15. This approach gives a more realistic comparison of the relative attainment of siblings, because it adjusts for the pattern of deterioration in growth attainment with age, or, in time-series terminology, it is detrended. The result is an approximate country-specific standardization for age.

Because of the relatively small size of the three samples, the number of cases in each one month age group is commonly around 20-30, with a range from 7 to 53 over the three countries. As a consequence the means fluctuate markedly. In order to reduce these fluctuations the monthly means were smoothed with a five-term weighted moving average, using the formula

$$\frac{x_1 + 2(x_2) + 3(x_3) + 2(x_4) + x_5}{9}$$

where x_3 is the value for the index month, x_1 and x_2 are the means for the two preceding months and x_4 and x_5 the means for the two succeeding months. The smoothed and unsmoothed monthly means for Ht/A and Wt/A for males and females for each country are depicted in Figures 7.5 to 7.10. The two values at the beginning and end of each sequence are unsmoothed original values, since no information was available for earlier or later age groups.



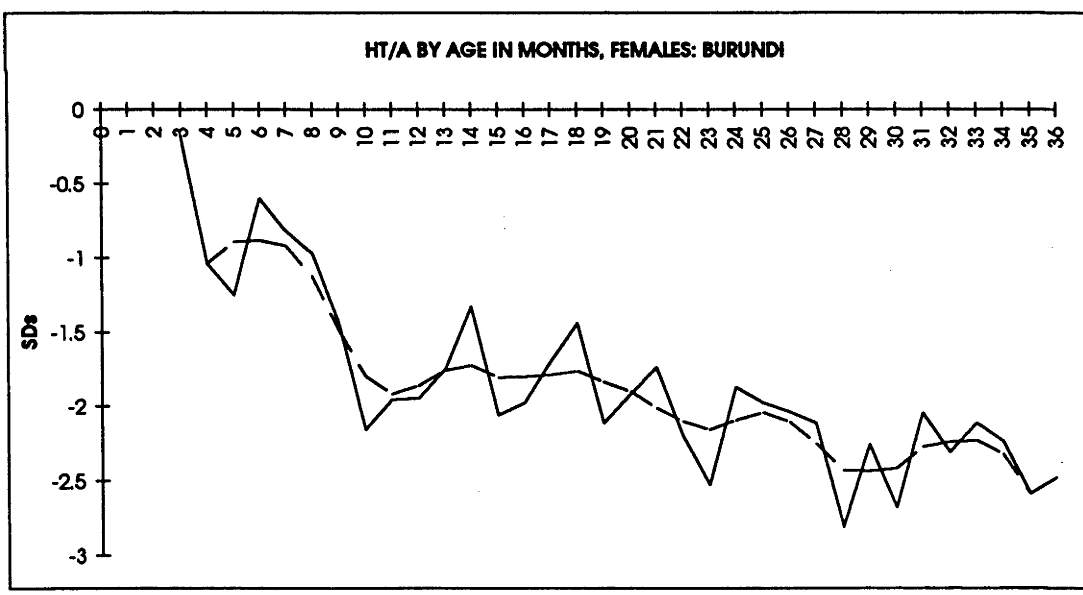
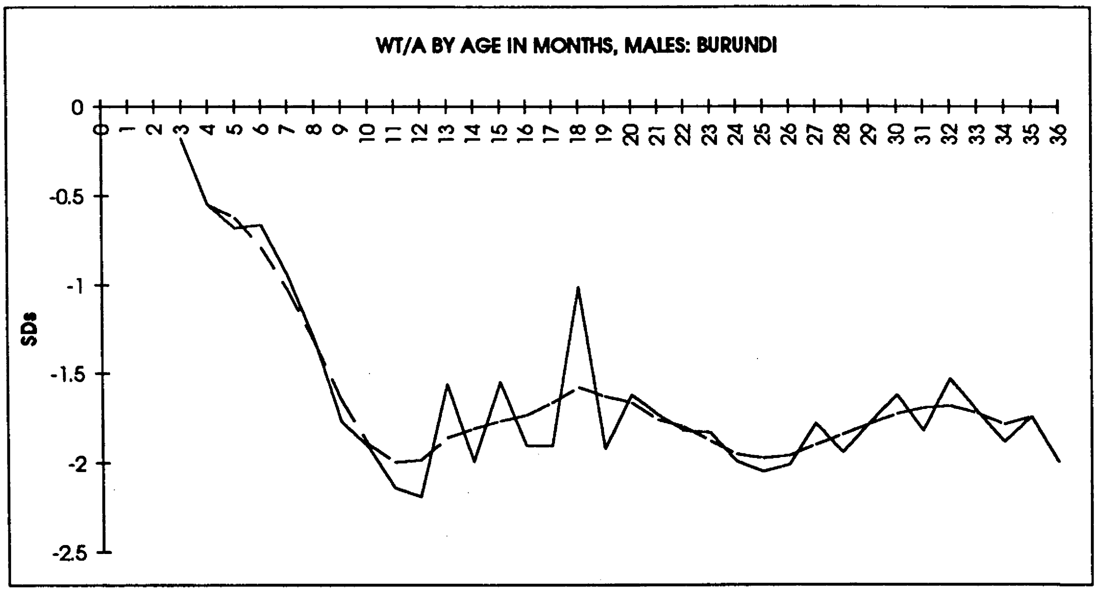


Figure 7.5: SMOOTHED MEAN Z-SCORES, HT/A: BURUNDI



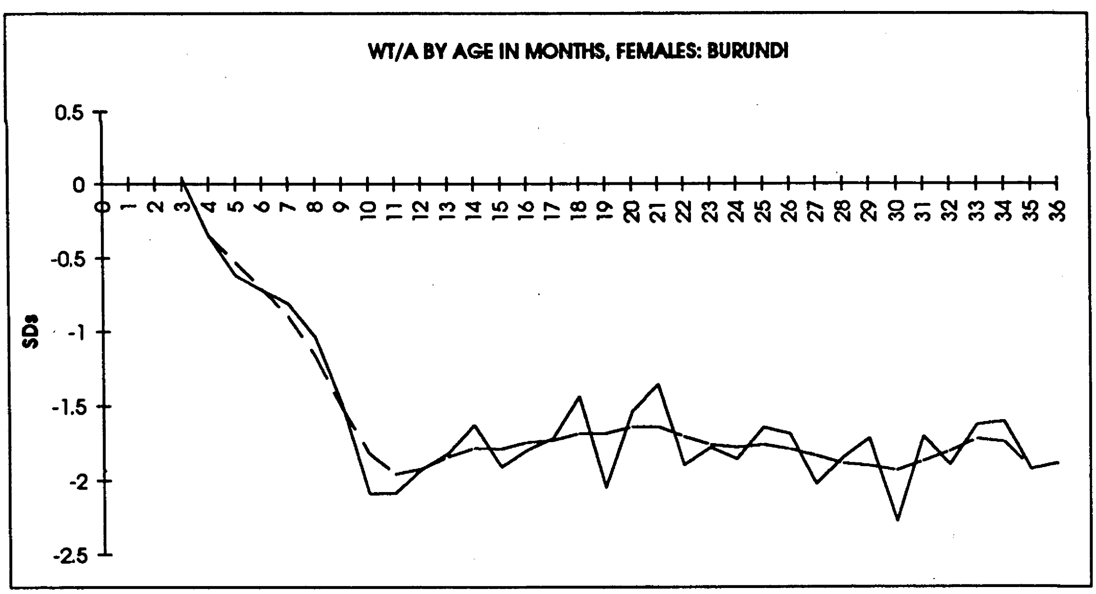
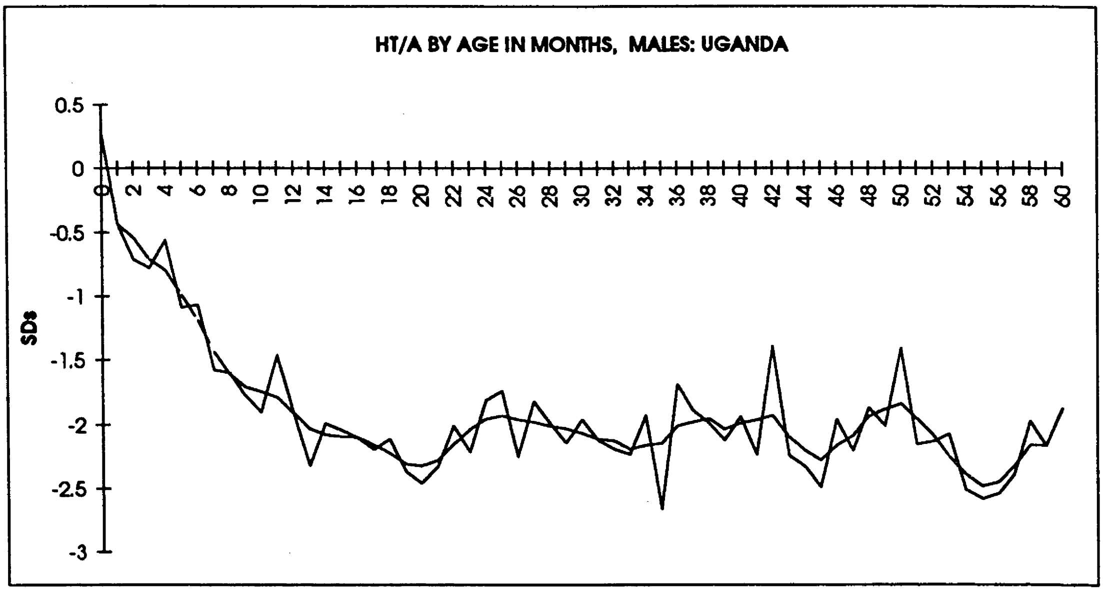


Figure 7.6: SMOOTHED MEAN Z-SCORES, WT/A: BURUNDI



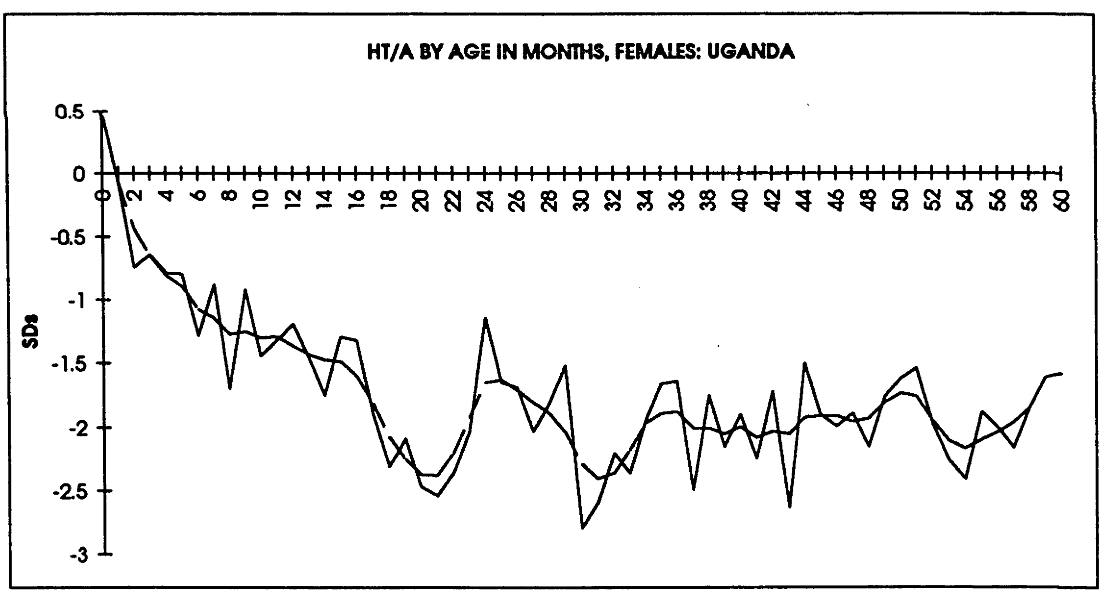
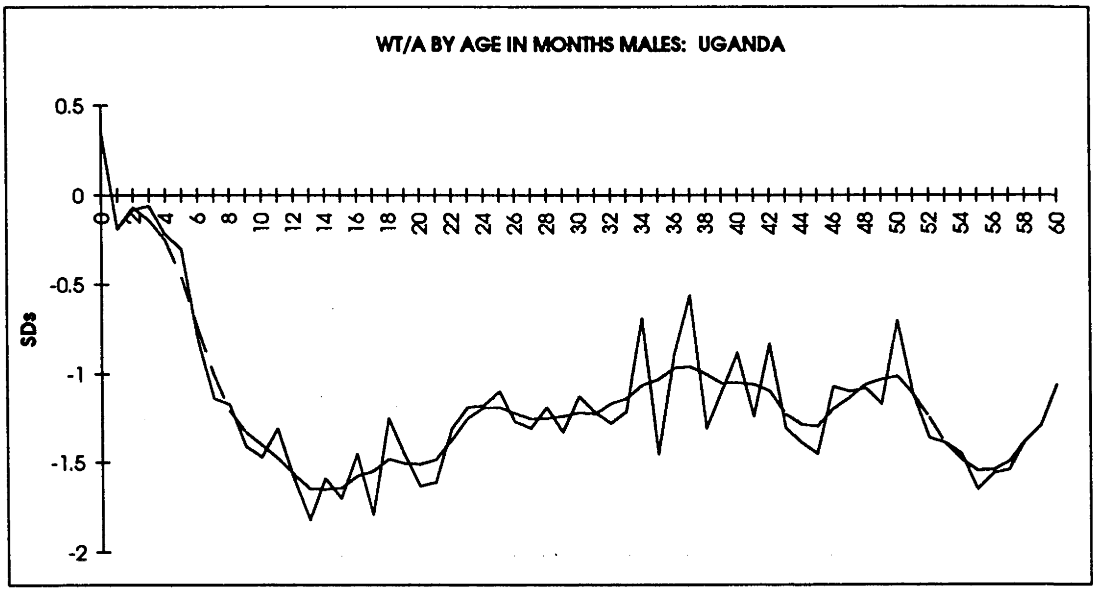


Figure 7.7: SMOOTHED MEAN Z-SCORES HT/A: UGANDA



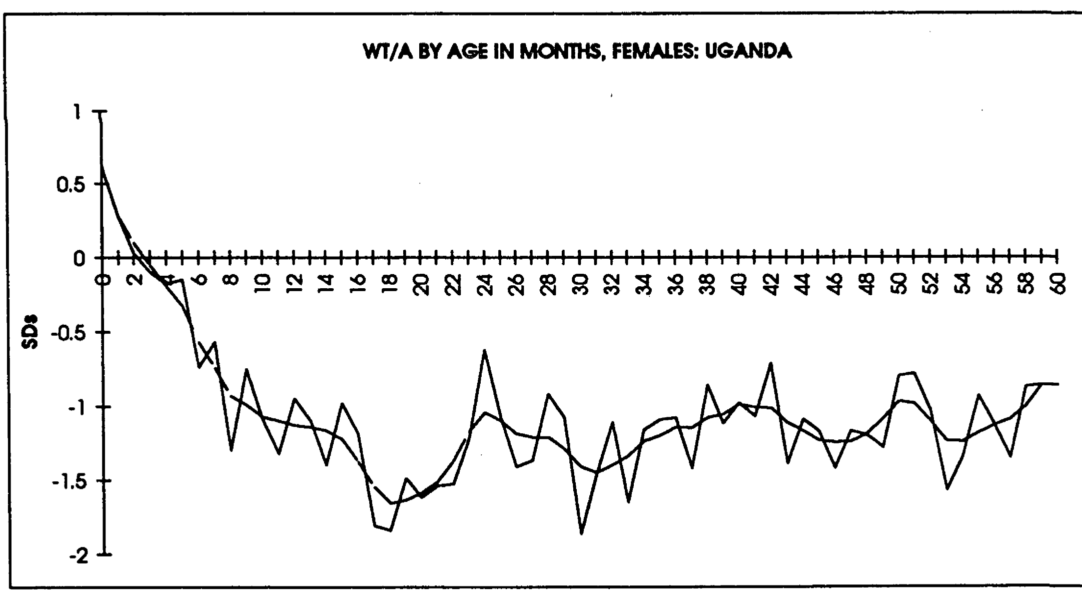
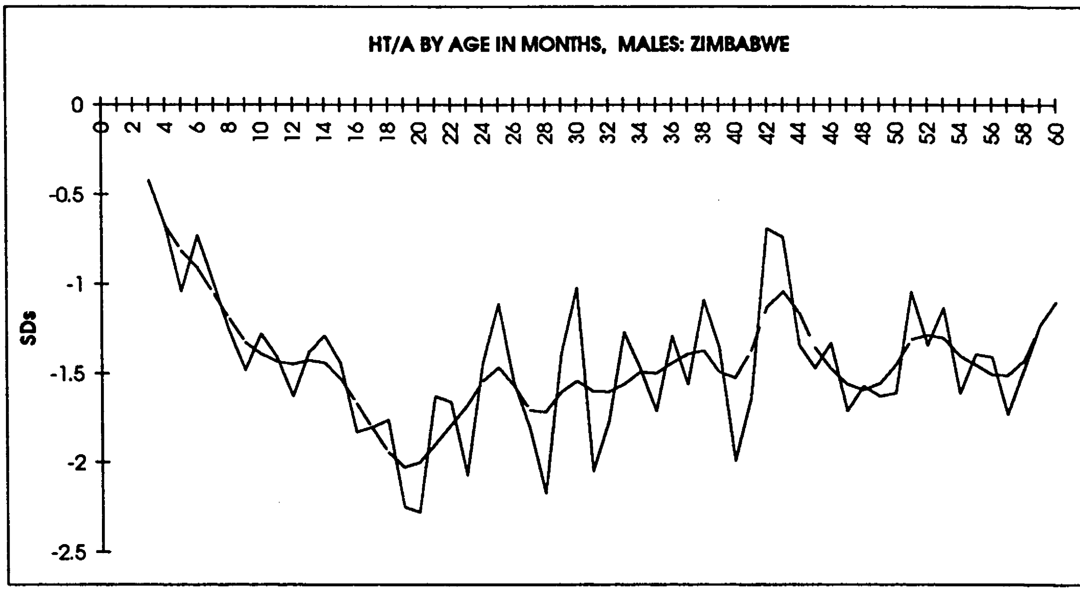


Figure 7.8: SMOOTHED MEAN Z-SCORES, WT/A: UGANDA



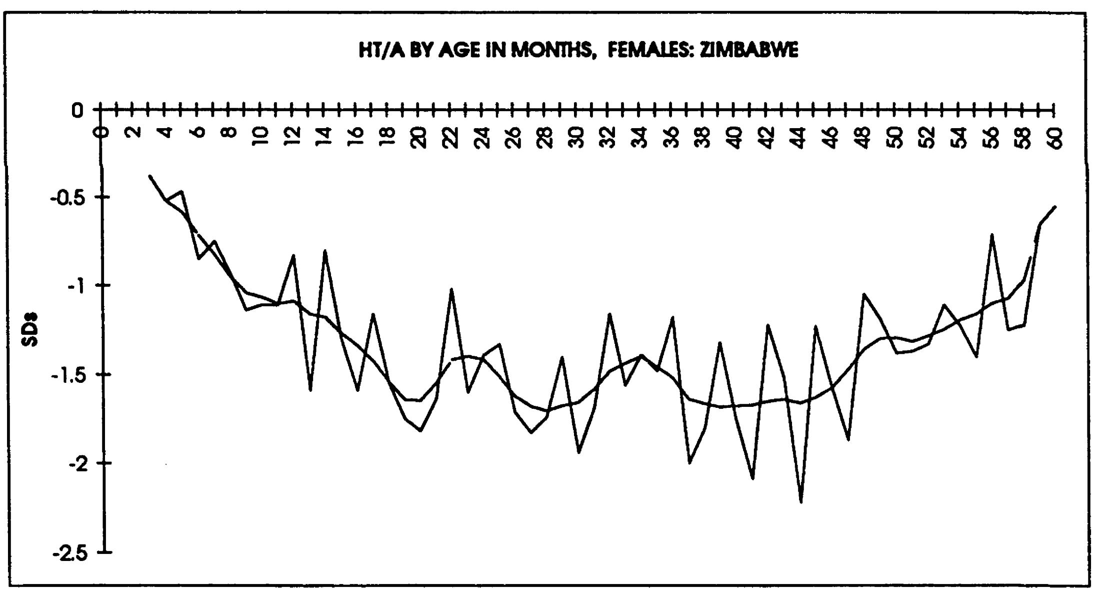
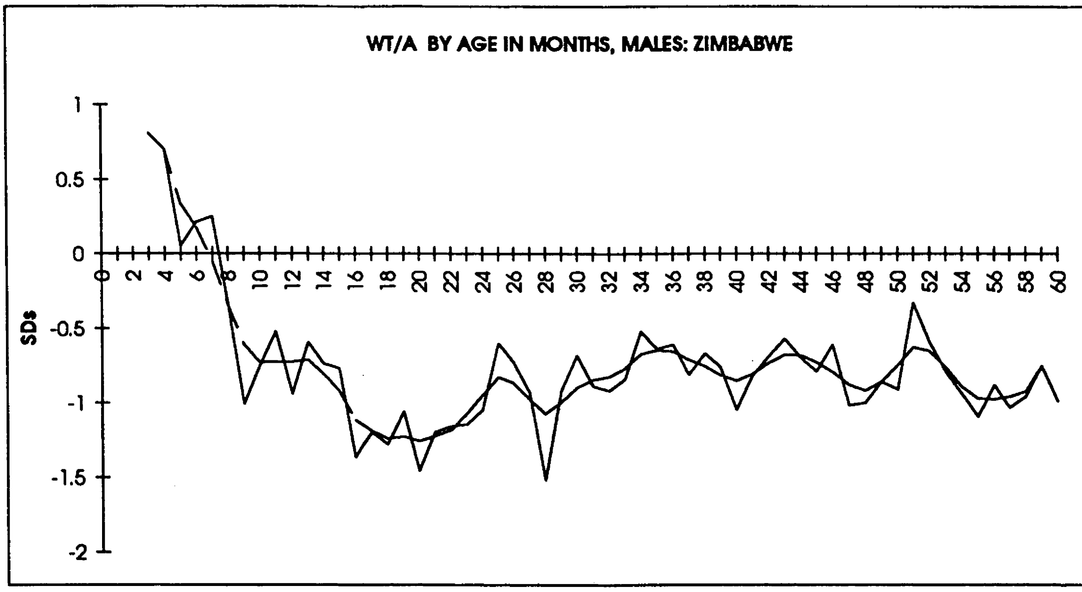


Figure 7.9: SMOOTHED MEAN Z-SCORES, HT/A: ZIMBABWE



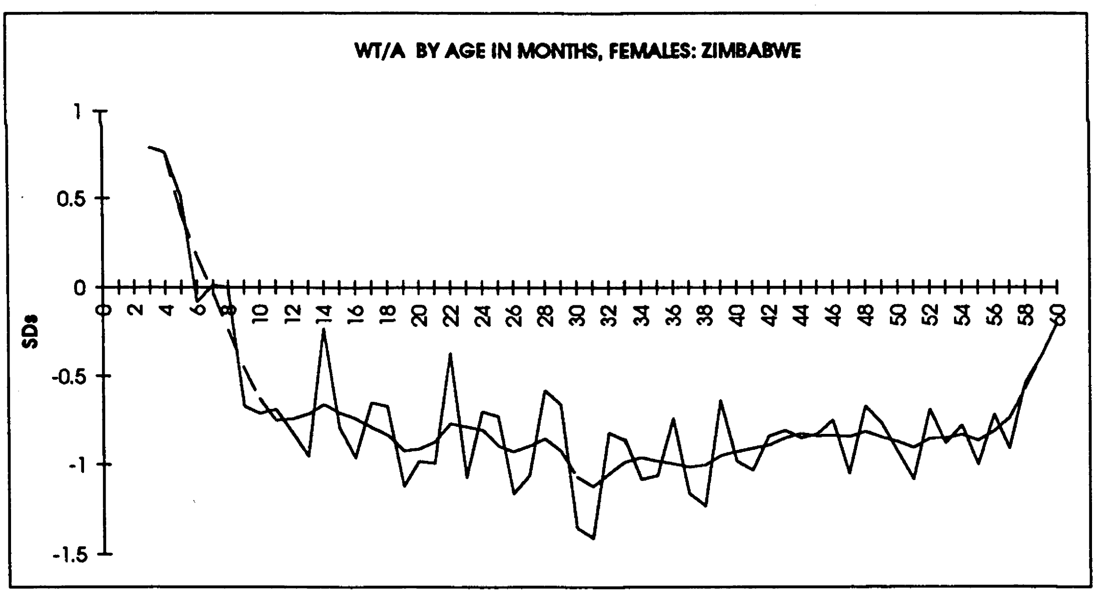


Figure 7.10: SMOOTHED MEAN Z-SCORES, WT/A: ZIMBABWE

The first step in the calculation of the difference between siblings was to subtract the appropriate smoothed mean value for each child from the actual Z-score for each child. The means for both youngest and second-youngest siblings are those for all measured children in each country, separately by sex. For example, the Ugandan male mean Ht/A for age eight months is -1.61. Hence a Ugandan male youngest child with a Ht/A score of -1.98 received an adjusted score of -0.37,

i.e. (-1.98) - (-1.61) = -0.37

A Ugandan second-youngest female child aged eighteen months would have a mean of -2.31 subtracted from her reported Ht/A score. The resulting value for the second-youngest sibling in each pair was then subtracted from that of the youngest. This approach was chosen because younger children are generally better off in relation to the reference value. Hence the usual expectation is that older children will be disadvantaged relative to younger children, rather than the reverse. In fact, subtracting the mean for each age controls for the usual expected difference, so the expected relationship becomes no difference between siblings. However, given that some starting point is needed for comparison, the attainment of second-youngest child relative to youngest was considered most logical.

The resulting variable, *difference between siblings*, is a characteristic of the mother that can be related to her other characteristics. Since this variable incorporates control for the expected growth pattern by age, there should be no significant difference between siblings, and no significant relationship between this variable and other maternal characteristics. Significant disadvantage of second-youngest children relative to youngest children would be expected to be an indicator of unfavourable socio-economic, demographic or environmental conditions. Conversely, where second-youngest children are significantly better off than youngest children, particularly favourable family circumstances would be expected. Figures 7.11 to 7.13 plot the differences, in standard deviations. It can be seen that in all three countries the distribution is approximately normal.

A major limitation of bi-variate analysis is that interval variables, such as *difference between siblings*, must be grouped into manageable categories. This requires the selection of one or more cut-off points. As the distribution of the difference between youngest and second-youngest children is approximately normal in all three countries, a

Figure 7.11: DIFFERENCE BETWEEN SIBLINGS, BURUNDI

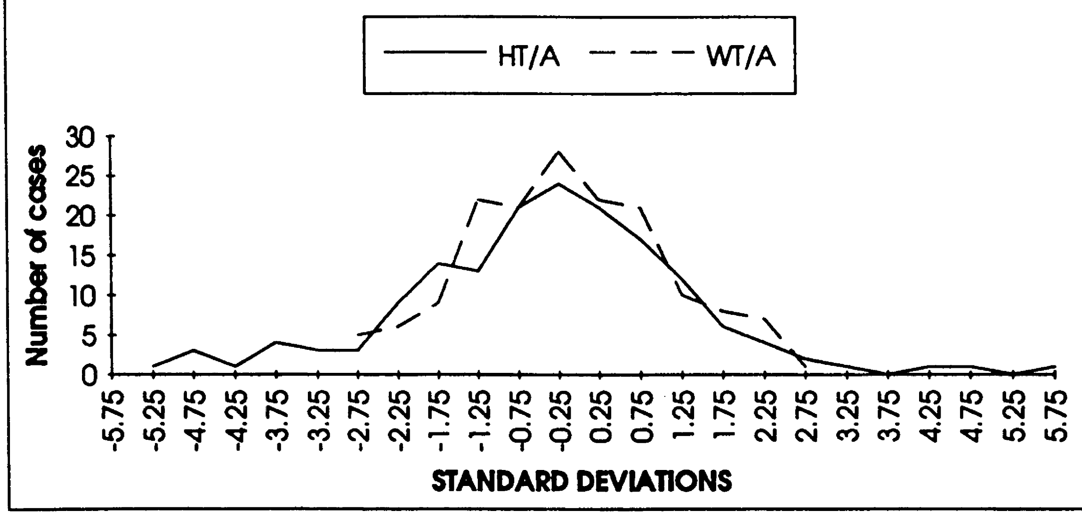


Figure 7.12: DIFFERENCE BETWEEN SIBLINGS, UGANDA

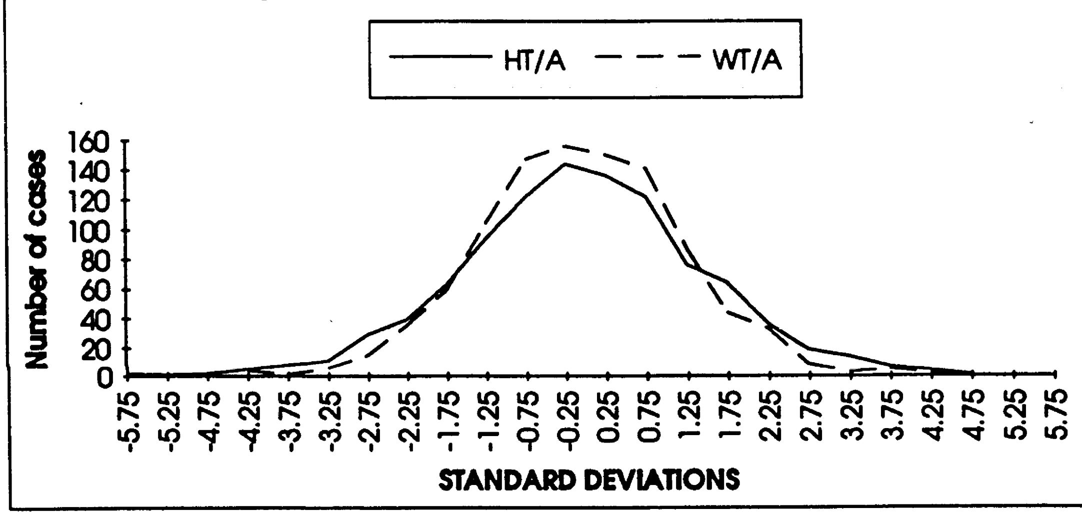
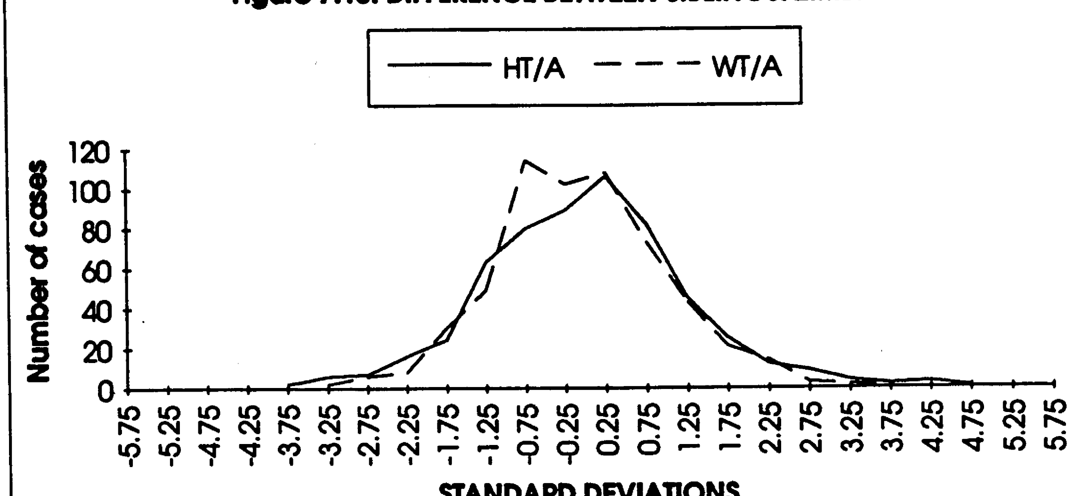


Figure 7.13: DIFFERENCE BETWEEN SIBLINGS: ZIMBABWE



SOURCE: As for Tables 4.4, 4.5 and 4.6.

difference of plus or minus 1 SD was arbitrarily selected for the bi-variate analysis. This is in keeping with the objective of identifying cases which are substantially at variance from the expected pattern, and is not intended to signify that the 1 SD cut-off point has any particular implication for growth attainment or health of siblings.

The difference between siblings was classified as 2nd youngest 1 SD or more below the mean, to indicate disadvantage, -0.99 to 0.99 SD to indicate no noticeable difference, and 1SD or more above to indicate advantage for the second-youngest children. The reclassified variable was then crosstabulated with the socio-economic, demographic and environmental variables used in previous chapters.

The results are presented in Tables 7.13 to 7.17. It can be seen that, when these cut-off points are used, only a few variables show a significant deviation from the expected pattern in any of the countries. This lends support to the hypothesis that, generally, differences between siblings are small when controls are introduced for the typical pattern of growth attainment in each country. There are no significant differences in Ht/A in either Burundi or Zimbabwe, but *birth interval, mother's age, dead sibling, mother's education, mother's literacy* and *region of residence* were all significant in Uganda. A short birth interval between the youngest and second-youngest, and having a dead sibling, is associated with more disadvantaged youngest siblings. This suggests that it is the youngest child of the pair who suffers most in families were a child has died and where there are hort birth intervals. This is consistent with the pattern in Tables 6.14, 6.15 and 6.16, where a short preceding birth interval tends to increase a child's risk of being stunted or underweight.

Mother's age produces a U-shaped curve, with youngest and oldest mothers most likely to have a disadvantaged second-youngest child. Having an educated or a literate mother tends to bring advantage to the second-youngest child. More second-youngest children were disadvantaged in West Nile Province, which is consistent with generally poor growth attainment in that province.

Tables 7.16, 7.17 and 7.18 compare Wt/A of youngest and second-youngest child. In Burundi the only significant difference occurs if both children are male, when fewer second-youngest children are disadvantaged. This pattern also is significant in Uganda. The only other significant variable in Uganda is *short birth interval*, which, again, is associated with advantage to the second-youngest child. In Zimbabwe, only place of

Table 7.13: HT/A OF SECOND YOUNGEST CHILD RELATIVE TO YOUNGEST CHILD BY SOCIO-ECONOMIC, DEMOGRAPHIC AND ENVIRONMENTAL CHARACTERISTICS: BURUNDI

Difference:	-1 SD	Same	+1 SD
ALL	16.5	51.6	31.9
Birth interval	Not Significant at 5% level		
Mother's age	Not Significant at 5% level		
Dead sibling	Not Significant at 5% level		
No. of children under 5 yrs	Not Significant at 5% level		
Both male	Not Significant at 5% level		
Both female	Not Significant at 5% level		
Youngest male	Not Significant at 5% level		
Youngest female	Not Significant at 5% level		
Mother's education	Not Significant at 5% level		
Mother's literacy	Not Significant at 5% level		
Husband's education	Not Significant at 5% level		
Husband's literacy	Not Significant at 5% level		
Husband's occupation	Not Significant at 5% level		
Husband lives elsewhere	Not Significant at 5% level		
Electricity	Not Significant at 5% level		
Refrigerator	Not Significant at 5% level		
Source of drinking water	Not Significant at 5% level		
Distance to water	Not Significant at 5% level		
Type of toilet facility	Not Significant at 5% level		
Region of residence	Not Significant at 5% level		
Place of residence	Not Significant at 5% level		
Number in household	Not Significant at 5% level		
2nd youngest had diarrhoea	Not Significant at 5% level		

SOURCE: As for Table 4.4

Table 7.14: HT/A OF SECOND YOUNGEST CHILD RELATIVE TO YOUNGEST CHILD BY SOCIO-ECONOMIC, DEMOGRAPHIC AND ENVIRONMENTAL CHARACTERISTICS: UGANDA

Difference:	-1 SD	Same	+1 SD	
ALL	21.4	53.2	25.5	n=1025
Birth interval				
Up to 24 mnths	15.7	48.1	36.3	388
> 24 mnths	25.3	56.3	18.4	637
p=< 0.0001				
Mother's age				
15-19	27.1	56.1	16.8	43
20-24	20.3	60.5	19.2	251
25-29	21.3	53.2	25.5	320
30-34	23.5	50.0	26.5	208
35-39	18.1	50.5	31.4	137
40-44	24.5	34.5	41.0	55
45-49	35.0	60.2	4.7	12
p=<0.05				
Dead sibling				
No	24.3	53.6	22.2	587
Yes	18.1	52.7	29.2	438
p=< 0.05				
Mother's education				
None	26.0	47.5	26.5	447
Primary	19.4	57.4	23.2	513
Secondary +	8.7	59.3	32.1	64
p= <0.01				
Mother's literacy				
Reads	15.9	58.9	25.2	359
Cannot read or poor	24.9	49.9	25.3	660
p=< 0.01				
Region of residence				
West Nile	32.0	60.0	8.0	41
East	13.3	61.9	24.8	272
Central	23.8	45.1	31.0	232
West	17.1	61.0	22.0	67
South West	26.5	50.2	23.3	364
Kampala	18.6	48.8	32.6	48
p=<0.001				

Mother's age	Not Significant at 5% level
No. of children under 5 yrs	Not Significant at 5% level
Both male	Not Significant at 5% level
Both female	Not Significant at 5% level
Youngest male	Not Significant at 5% level
Youngest female	Not Significant at 5% level
Husband's education	Not Significant at 5% level
Husband's literacy	Not Significant at 5% level
Husband's occupation	Not Significant at 5% level
Religion	Not Significant at 5% level
Husband lives elsewhere	Not Significant at 5% level
Place of residence	Not Significant at 5% level
Electricity	Not Significant at 5% level
Refrigerator	Not Significant at 5% level
Source of drinking water	Not Significant at 5% level
Distance to water	Not Significant at 5% level
Type of toilet facility	Not Significant at 5% level
Place of residence	Not Significant at 5% level
Number in household	Not Significant at 5% level
2nd youngest had diarrhoea	Not Significant at 5% level

SOURCE: As for Table 4.5.

Table 7.15: HT/A OF SECOND YOUNGEST CHILD RELATIVE TO YOUNGEST CHILD BY SOCIO-ECONOMIC, DEMOGRAPHIC AND ENVIRONMENTAL CHARACTERISTICS, ZIMBABWE

Difference:	-1 SD	Same	+1 SD	
ALL	17.5	61.7	20.8	n=577
Birth interval	Not Significant at 5% level			
Mother's age	Not Significant at 5% level			
Dead sibling	Not Significant at 5% level			
No. of children under 5 yrs	Not Significant at 5% level			
Both male	Not Significant at 5% level			
Both female	Not Significant at 5% level			
Youngest male	Not Significant at 5% level			
Youngest female	Not Significant at 5% level			
Mother's education	Not Significant at 5% level			
Mother's literacy	Not Significant at 5% level			
Husband's education	Not Significant at 5% level			
Husband's literacy	Not Significant at 5% level			
Husband's occupation	Not Significant at 5% level			
Language	Not Significant at 5% level			
Religion	Not Significant at 5% level			
Husband lives elsewhere	Not Significant at 5% level			
Electricity	Not Significant at 5% level			
Refrigerator	Not Significant at 5% level			
Source of drinking water	Not Significant at 5% level			
Distance to water	Not Significant at 5% level			
Type of toilet facility	Not Significant at 5% level			
Region of residence	Not Significant at 5% level			
Place of residence	Not Significant at 5% level			
Strata	Not Significant at 5% level			
Number in household	Not Significant at 5% level			
2nd youngest had diarrhoea	Not Significant at 5% level			

SOURCE: As for Table 4.6.

Table 7.16: WT/A OF SECOND YOUNGEST CHILD RELATIVE TO YOUNGEST CHILD BY SOCIO-ECONOMIC, DEMOGRAPHIC AND ENVIRONMENTAL CHARACTERISTICS: BURUNDI

Difference:		-1 SD	Same	+1 SD
ALL	16.2	56.9	26.9	n=157
Both Male				
No	25	63.4	11.7	115
Yes	13	54.6	32.4	41
	p= < 0.05			

Birth interval	Not significant at 5% level
Mother's age	Not significant at 5% level
Dead sibling	Not significant at 5% level
No. of children under 5 yrs	Not significant at 5% level
Both female	Not significant at 5% level
Youngest male	Not significant at 5% level
Youngest female	Not significant at 5% level
Mother's education	Not significant at 5% level
Mother's literacy	Not significant at 5% level
Husband's education	Not significant at 5% level
Husband's literacy	Not significant at 5% level
Husband's occupation	Not significant at 5% level
Husband lives elsewhere	Not significant at 5% level
Electricity	Not significant at 5% level
Refrigerator	Not significant at 5% level
Source of drinking water	Not significant at 5% level
Distance to water	Not significant at 5% level
Type of toilet facility	Not significant at 5% level
Region of residence	Not significant at 5% level
Place of residence	Not significant at 5% level
Number in household	Not significant at 5% level
2nd youngest had diarrhoea	Not significant at 5% level

Table 7.17: WT/A OF SECOND YOUNGEST CHILD RELATIVE TO YOUNGEST CHILD BY SOCIO-ECONOMIC, DEMOGRAPHIC AND ENVIRONMENTAL CHARACTERISTICS: UGANDA

Difference:	-1 SD	Same	+1 SD	
ALL	18.4	59.2	22.5	n=1004
Birth interval				
Up to 24 months	13.4	58.3	28.3	396
More than 24 montr	21.6	59.7	18.6	606
p=< 0.0001				
Both male				
No	17.7	61.6	20.7	752
Yes	20.4	52	27.6	250
p= < 0.05				

Mother's age	Not Significant at 5% level
Dead sibling	Not Significant at 5% level
No. of children under 5 yrs	Not Significant at 5% level
Both female	Not Significant at 5% level
Youngest male	Not Significant at 5% level
Youngest female	Not Significant at 5% level
Mother's education	Not Significant at 5% level
Mother's literacy	Not Significant at 5% level
Husband's education	Not Significant at 5% level
Husband's literacy	Not Significant at 5% level
Husband's occupation	Not Significant at 5% level
Religion	Not Significant at 5% level
Husband lives elsewhere	Not Significant at 5% level
Region of residence	Not Significant at 5% level
Place of residence	Not Significant at 5% level
Electricity	Not Significant at 5% level
Refrigerator	Not Significant at 5% level
Source of drinking water	Not Significant at 5% level
Distance to water	Not Significant at 5% level
Type of toilet facility	Not Significant at 5% level
Place of residence	Not Significant at 5% level
Number in household	Not Significant at 5% level
2nd youngest had diarrhoea	Not Significant at 5% level

SOURCE: As for Table 4.5.

Table 7.18: WT/A OF SECOND YOUNGEST CHILD RELATIVE TO YOUNGEST CHILD BY SOCIO-ECONOMIC, DEMOGRAPHIC AND ENVIRONMENTAL CHARACTERISTICS: ZIMBABWE

Difference:	-1 SD	Same	+1 SD	
ALL	14.7	68.5	16.8	n=577
Place of residence				
Rural	13.4	71.3	15.3	463
Urban	20.2	57	22.8	114
$p = < 0.05$				

Birth interval	Not Significant at 5% level
Mother's age	Not Significant at 5% level
Dead sibling	Not Significant at 5% level
No. of children under 5 yrs	Not Significant at 5% level
Both male	Not Significant at 5% level
Both female	Not Significant at 5% level
Youngest male	Not Significant at 5% level
Youngest female	Not Significant at 5% level
Mother's education	Not Significant at 5% level
Mother's literacy	Not Significant at 5% level
Husband's education	Not Significant at 5% level
Husband's literacy	Not Significant at 5% level
Husband's occupation	Not Significant at 5% level
Language	Not Significant at 5% level
Religion	Not Significant at 5% level
Husband lives elsewhere	Not Significant at 5% level
Electricity	Not Significant at 5% level
Refrigerator	Not Significant at 5% level
Source of drinking water	Not Significant at 5% level
Distance to water	Not Significant at 5% level
Type of toilet facility	Not Significant at 5% level
Region of residence	Not Significant at 5% level
Strata	Not Significant at 5% level
Number in household	Not Significant at 5% level
2nd youngest had diarrhoea	Not Significant at 5% level

SOURCE: As for Table 4.6.

Table 7.19: REGRESSION MODEL OF DIFFERENCE IN DETRENDED Z-SCORE BETWEEN YOUNGEST AND SECOND YOUNGEST CHILD; BURUNDI

HT/A	B	T	Sign. T	2 youngest c.f. youngest
No toilet facility	2.7231	3.41	0.0008	Positive*
Surface water	-0.7027	-2.564	0.0113	Negative
Husband 2y	1.1938	2.204	0.0291	Positive
Dead sibling	0.6400	2.294	0.0232	Positive
Both female	0.6656	2.111	0.0364	Positive
Mumirwa	0.7825	1.991	0.0483	Positive
Constant 0.14				
Adj r2 0.15				
n 156				
WT/A				
No toilet facility	1.6260	2.829	0.0053	Positive*
No. children under 5yrs	-0.3478	-2.609	0.01	Positive
Husband primary	-0.4698	-2.308	0.0224	Negative
Mumirwa	0.6571	2.185	0.0304	Positive
Constant 1.27				
Adj r2 0.11				
n 156				

*=only four cases

SOURCE: As for Table 4.4.

residence was significantly associated with Wt/A, with a higher percentage of second-youngest children disadvantaged in urban areas.

The last stage in this analysis was to explore factors contributing to a wider difference between siblings, as an interval dependent variable in an OLS regression model, rather than as an ordinal variable. Because the expectation was that there would be little or no difference, all of the above variables, plus age of the second-youngest child, were included in the model, in order to search for effects when controls for the effects of other variables were introduced. An interaction term, *age of youngest child* multiplied by *birth interval between siblings*, was included to allow for non-linearity.

It must be noted that, since the dependent variable is *difference between siblings*, the regression analysis simply models the magnitude of the difference and does not relate to the reference median. Hence if the means for all second-youngest children were -0.05 below that of all youngest children, and the means for second-youngest children of a subgroup of mothers in, say, urban areas were -0.03, living in urban areas would have a positive effect of 0.02. Similarly, an overall mean difference of +0.05, with a mean of +0.07 for urban children would produce a positive effect of urbanization of 0.02.

It also is important to note that the dependent variable in the regression analysis is simply the magnitude of the difference. A positive coefficient signifies an increase in the difference, and a negative coefficient a decrease. However, the coefficients do not indicate which child is disadvantaged. The right hand columns of Tables 7.19, 7.20 and 7.21 indicate whether the second-youngest child is advantaged (positive) or disadvantaged (negative) relative to the youngest, as the values of the independent variables change. This column was derived from simple cross-tabulations of difference with each of the significant variables (not shown). It indicates the general tendency in the growth attainment of the second-youngest child relative to that of the youngest child, even though most relationships were not statistically significant when values were regrouped for meaningful tabulation.

Several of the variables featured in the bi-variate analysis disappeared from the multi-variate model, including *both male* for Burundi and Uganda Wt/A, *mother's education* and *literacy* for Uganda Ht/A and *place of residence* for Zimbabwe Wt/A.

The results for Burundi in Table 7.19 show that an educated, and hence privileged, husband is an advantage to Ht/A of the second-youngest, as is living in Mumirwa, where levels of stunting and wasting are generally lower. Having a dead sibling increases the advantage to the second-youngest child compared with the youngest. Presumably a dead sibling, born either before the second-youngest or between the youngest and second-youngest, brings the advantage of a longer birth interval and less competition for food. Both children being female also gives an advantage to the second-youngest. Predictably, a surface drinking water source both disadvantages the second-youngest and reduces the difference between siblings, presumably by increasing the risk of diarrhoea, to which older children are more exposed. Not having any toilet facility would also be expected to have this effect, but the results for both Ht/A and Wt/A are unreliable because of the very small number of cases.

In the model for Wt/A, *number of children under age five* reduces the difference, with the second-youngest child having a slight advantage as numbers increase, presumably because the youngest is affected by maternal factors associated with frequent pregnancies. *Primary educated husband* reduces the difference, with relative disadvantage to the second-youngest. *Living in Mumirwa* increases the difference and the advantage of the second-youngest. The adjusted r^2 value for Ht/A indicates that more than 15 per cent of the variation is explained by the model, while that for Wt/A is more than 10 per cent.

Table 7.20: REGRESSION MODEL OF DIFFERENCE IN DETRENDED Z-SCORE BETWEEN YOUNGEST AND SECOND YOUNGEST CHILDREN; UGANDA

HT/A		B	T	Sign. T	2 youngest c.f youngest
Birth interval		-0.0548	-8.97	0.0000	Long=Negative
Mother's age		0.0304	3.824	0.0001	Older=Positive
South West		-0.3069	-2.989	0.0029	Negative
No. children under 5 yrs		0.1138	-2.029	0.0428	More=Negative
Constant		1.1034			
Adj r2	0.09				
n	924				

WT/A		B	T	Sign. T	
Birth interval		-0.0354	-7.009	0.0000	Long=Negative
Distance to water		0.1018	2.647	0.0083	Far=Negative
Mother's age		0.0249	0.00719	0.0006	Older=Positive
Number in household		-0.0357	0.014846	0.0165	More=Negative
Constant		0.3653			
Adj r2	0.06				
n	903				

Source: As for Table 4.5.

Table 7.20 shows that, in Uganda, longer birth intervals are associated with a reduction in the difference in both Ht/A and Wt/A, although the second-youngest becomes increasingly disadvantaged with longer birth intervals. This is probably a reflection of the older age of the second-youngest, and hence longer exposure to poor living conditions, when the birth interval is long. *South West* region reduces the difference also, with a negative effect on the second-youngest. The difference in both Ht/A and Wt/A increases with *mother's age,* with older mothers having a positive effect on the second-youngest. A greater *number of children under age five* is associated with a bigger difference in Ht/A but a greater *number in household* tends to reduce the difference in Wt/A. However, both have a negative effect on the second-youngest child presumably because the number of competing siblings increases. The adjusted r^2 values for Uganda are smaller than those for Burundi, with that for Ht/A 9 per cent, and that for Wt/A just over 6 per cent.

Birth interval produces a reduction in the difference between youngest and second-youngest in Zimbabwe Ht/A in Table 7.21, with longer intervals having a positive effect on the second-youngest. This reflects the improvement in Z-scores among older Zimbabwean children, as shown in Figures 5.15 and 5.16, which is in contrast to the pattern for Uganda. *Number of children under age five* reduces the difference, but, in contrast to Burundi, more children have a negative effect on the second-youngest. This is probably a reflection of the narrower age range of the Burundi sample compared with that for Zimbabwe. *Commercial farm strata* increases the difference, and rather unexpectedly, has a positive effect on the second youngest, suggesting that infants are most affected

by the poor conditions. As in Uganda, higher values for *mother's age* both increase the difference and the advantage to the second-youngest child. The Zimbabwe Ht/A model was the only one in which the interaction term, *age of youngest child multiplied by birth interval,* was significant. This indicates a non-linear relationship, with the difference reducing as values increase, although older children remain advantaged.

Higher *age of the second-youngest child* reduces the difference in Wt/A in Zimbabwe and is associated with an advantage to the second youngest, reflecting the benefits of a longer birth interval. *Husband in professional employment* and *mother with no education* both produce a greater difference in Wt/A, and an advantage for the second-

Table 7.21: REGRESSION MODEL OF DIFFERENCE IN DETRENDED Z-SCORE BETWEEN YOUNGEST AND SECOND YOUNGEST CHILDREN; ZIMBABWE

HT/A		B	T	Sign. T	2 youngest c.f. youngest
Birth interval		-0.0267	-4.207	0.0000	Long=Positive
Commercial farm		0.3909	2.854	0.0045	Positive
No. children under 5 yr		-0.2505	-3.118	0.0019	More=Negative
Youngest age* birth interval		-7.2440	-3.003	0.0028	High=Positive
Mother's age		0.0194	2.213	0.0273	Older=Positive
Constant		1.0907			
Adj r2	0.05				
n	576				
WT/A					
Age of 2nd youngest		-0.0195	-3.926	0.0001	Older=Positive
Husband professional		0.4793	2.511	0.0123	Positive
Mother no education		0.2620	2.398	0.0168	Positive
No. children under 5 yr		-0.1551	-2.245	0.0251	More=Negative
Constant		1.2407			
Adj r2	0.04				
n	576				

Source: As for Table 4.6.

youngest. *Number of children under age five* reduces the difference, with increasing numbers disadvantaging the second youngest. In both Zimbabwe models the adjusted r^2 values are small, less than six.

These regression models demonstrate convincing associations of some factors with the difference between siblings. However, the small r^2 values and the large number of variables excluded from the model tend to confirm the hypothesis that, once the age pattern is controlled, differences in the growth attainment of the second-youngest child compared with that of the youngest are not great. It is not possible to reach a firm conclusion because of the relatively small numbers of cases in all three countries, which cause erratic means for each one month age group, and result in a relatively small number of pairs of siblings. Nonetheless, this technique could be used effectively with a larger number of cases to identify factors associated with the growth attainment of one sibling relative to another.

7.6 DISCUSSION

Measurement of the existence of clustering of mortality among mothers is complicated by varying degrees of exposure to risk according to parity, and their own and their children's age. There is also the complication that a single death disproportionately increases the risk factor of women of low parity compared to that of women of higher parities. The preceding analysis incorporated controls for different exposure to risk and for the disproportionate effect of a single death at low parities. The results suggest that there is some clustering of deaths among mothers in all three study countries, and that it is inversely related to mortality rates.

There is less evidence that poor growth attainment, morbidity and mortality tend to occur together within families, although measurement of these associations presents fewer difficulties than the measurement of clustering of deaths. This is consistent with the findings in Chapters Four and Six, that the correlates of mortality and poor growth attainment tend to differ. That is, most correlates of infant and child mortality are demographic factors, whereas most correlates of poor growth attainment, and especially stunting, reflect environmental quality and sibling competition. This would appear to confirm the view of writers such as van Lerberghe (1988) and Tomkins (1988), discussed in Section 5.2.3, who pointed out that stunting is not strongly correlated with mortality. It is also interesting to note that, in almost all cases, when both stunting and underweight occur within one family they usually affect the same child, but this child is not necessarily wasted. This supports the view of writers such as Royer and Waterlow (1985) and Mora (1985), that, although not the most desirable outcome, stunting adapts the child to a lower food intake and a lower than normal weight, without necessarily increasing its mortality risk. Similarly, Gerein (1988: 233) pointed out that stunting is more likely to be associated with increased mortality when diarrhoeal and respiratory infections are frequent, than where medical services are good.

As stated previously, since no anthropometric data are available for dead children, it is not known what proportion of all dead children were wasted before death. Moreover, the bias towards lower parities among mothers of measured children, and hence lower exposure to the risk of child mortality, as well as the comparative rarity of wasting among surviving children, precludes a comprehensive analysis of the clustering of wasting with other factors. However, the literature suggests that wasting is the anthropometric indicator most likely to cluster with mortality.

The exploration of sibling growth attainment is also constrained by limitations in the size of the samples, particularly for Burundi. Nonetheless, the preceding analysis confirmed the expectation that, when controls are introduced for the age pattern of growth relative to reference values, differences in sibling growth attainment are usually small. Differences of more than 1 SD were associated primarily with short birth intervals, mother's and husband's education, husband's occupation and several environmental variables. Further exploration of patterns of sibling growth attainment with larger data sets could provide valuable information for the development of strategies for improving child health within families.

CHAPTER EIGHT: SUMMARY, POLICY RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

As observed in Chapter One, there is a well-developed literature and theoretical framework for the study of the correlates of child mortality and survival. On the other hand, little attention has been given to the development of a framework for the study of poor growth attainment. More commonly poor growth attainment has been viewed as a determinant of mortality, even though it is endemic in developing countries, and even though the majority of children with poor growth attainment survive. Surprisingly little attention has been given to differentiating the characteristics of children with poor growth attainment who die from those of survivors. Yet, since poor growth attainment alone is not a good predictor of mortality risk, there is a pressing need to identify other indicators which can be used, in conjunction with poor growth attainment, to identify children at risk.

This study has addressed this gap in knowledge, with a detailed examination of child growth attainment in three African countries, Burundi, Uganda and Zimbabwe, and a comparison of the correlates of mortality and poor growth attainment. Theory from both the medical and the social sciences has been linked where appropriate, and new approaches to the analysis of cross-sectional data on growth attainment have been proposed and explored. Three countries were chosen for the analysis so that common patterns could be identified. This study has therefore contributed not only to an understanding of the patterns of child growth and mortality in the three countries, but also to a better understanding of the general relationship of poor growth attainment and mortality.

The three specific research objectives of this study were to refine the theoretical framework for the study of growth attainment; to evaluate the utility of cross-sectional surveys for the study of child mortality and growth attainment; and to compare patterns and correlates of mortality and growth attainment across the three countries. This chapter summarises the findings and their policy implications and identifies areas which need further research.

The first objective was to refine the theoretical framework for the study of growth attainment. Chapter One suggests a new model, based on the Mosley and Chen framework, which is suitable for the analysis of growth attainment of both survivors and those who die (Figures 1.3 and 1.4). The new model emphasizes the interaction between environmental, socio-economic, demographic and child-care factors rather than defining socio-economic factors as underlying. The analysis in Chapter Six demonstrates high levels of interaction between all four groups of factors, which supports the view expressed in Chapter One that they should not be arranged hierarchically.

Whereas Mosley and Chen treated nutrition as one of the intervening variables that lead to sickness or health, in the new model morbidity, nutrition, genetic factors and condition at birth are considered together as the direct determinants of growth attainment. Data limitations prevented a thorough exploration of the synergy between morbidity and nutrition and the role of genetic factors and condition at birth. However, the analysis indicates that this model reflects the causal relationships which determine growth attainment, and is therefore suitable as a framework not only for cross-sectional studies but also for longitudinal studies, which are better able to distinguish the respective contributions of the determinants of growth attainment.

Since no data were available on a number of maternal factors, including pregnancy term and condition at birth, only limited analysis of neonatal child survival was possible in this study. However, the exploration of the correlates of low birthweight in Zimbabwe indicates that the causal model of neonatal survival proposed in Chapter One (Figure 1.3) would be an appropriate framework for studies which had access to more data.

The second major objective of this study was to evaluate the utility of cross-sectional surveys such as DHS as sources of data for the analysis of child mortality and growth attainment. In terms of mortality reporting, the data sets appear to be quite good. Table 7.2 showed plausible increases in the proportion dead by parity in both Uganda and Zimbabwe, indicating that reporting of child deaths was reasonably consistent in these countries, although less so in Burundi. However, surveys of this size are generally too small to provide reliable estimates of infant and child mortality rates in given time periods.

Van de Walle, Pison and Sala-Diakanda (1992: 2) commented that, despite their focus on fertility, one of the most important issues raised by the World Fertility Surveys (WFS) of the 1970s and 1980s was the precise relationship between socio-economic variables and mortality. But, although the question was raised, WFS data were not suitable for exploring mechanisms. They gave little coverage to the proximate determinants of mortality identified by Mosley and Chen (1984) and did not provide answers to the question of whether it is better to build a hospital or a school. Even if one accepts Caldwell's (1986: 202) view that this is a false dilemma, since both facilities contribute to better health, it must be conceded that until more is known about the mechanisms there can be no satisfactory answer to other essential planning questions such as 'What sort of school or health facility is best, and where should it be located?'.

Although DHS data sets include more questions on the proximate determinants of mortality, still they support only limited exploration of mechanisms, and are no better suited than WFS to providing precise guidance on social investment. This is largely due to their broad-ranging character, which makes it impractical to collect sufficient detail to explore fully topics such as health-service utilization. For example, analysis of the data sets shows that maternal education and literacy are associated with fewer child deaths (Tables 4.1, 4.2 and 4.3). However, it is not possible to draw firm conclusions about the mechanisms through which education affects child survival, since there is no information on cause of death or the health care given to dead children. In some cases information is available on the health care given to siblings of dead children, but this is not necessarily the same.

Similarly, the health module in the questionnaire does not support definitive conclusions about the relationship of child survival and growth with health care and nutrition. Mothers were asked about the type of care sought only for children who were sick during the two- or four-week reference period, so mothers whose children were not sick were excluded. Similarly, questions on breastfeeding and food supplementation were asked primarily to provide information on post-partum amenorrhoea, feeding patterns and weaning practices, and have only very limited use in the analysis of nutrition. As a consequence these data sets support only limited analysis of the causes of poor growth attainment.

On the other hand, as shown in Chapter Five, the measurements collected by DHS provide a valuable snapshot of growth attainment patterns across the samples. The anthropometric patterns are plausible, consistent with the literature, and similar in all three countries. Although these measurements cannot be used to study growth trends in individual children or to explore the relationship of growth attainment with infection and nutrition, they provide useful information on growth patterns at the population level. Also, it is apparent from the analysis in Chapter Six that the data sets point to convincing associations with determinants, which warrant further exploration.

It is also apparent that DHS does provide some of the data van de Walle, Pison and Sala-Diakanda (1992) considered necessary to enable the re-thinking of health policies in the light of a looming health crisis in Africa. They expressed the view that existing strategies which emphasise primary health care have been flawed by the limitations of community health workers and other breakdowns in service delivery. While immunization has been the flagship of the primary health care effort, neither growth monitoring nor ORT have proved themselves (van de Walle, Pison and Sala-Diakanda 1992: 8). However, the preceding analysis points not only to the dramatic effect of immunization in mortality reduction in all three countries, but also to an equally dramatic association of mother's knowledge of ORT with reduced mortality, especially among Zimbabwean children. Although this could be interpreted as a reflection of generally improved health practices, rather as a direct effect of ORT on mortality, it seems clear that health-care initiatives other than immunization are having a beneficial effect on child survival.

Thus, while DHS surveys do not provide all of the essential information necessary to address major issues of health planning, they do make a valuable contribution to the study of child survival. Their main strength is the identification of patterns of association which point to areas in need of further detailed research. Quantitative data, however broad, is an essential first step to provide hypotheses in any research. As the many comparative studies have demonstrated, the value of surveys such as DHS is perhaps greatest at the cross-country comparative level. They also support useful comparisons at the regional level within countries.

Perhaps the best recommendation that can be made is that governments and international agencies need to collect not only cross-sectional data, but also to mount long-term prospective studies. Although these studies are expensive, complex to administer and relatively slow to yield results, in the long run they are capable of linking inputs to outcomes in a way which is not possible with cross-sectional data. Projects such as Matlab in Bangladesh have demonstrated that they can yield a wide variety of information to address a number of different research topics, such as fertility, maternal mortality, child mortality and growth attainment, and to provide essential information for health policy decisions.

Country-specific, long-term prospective studies should be designed which collect as wide a range of socio-economic, environmental and demographic information as DHS cross-sectional surveys. These monitoring activities should include measurement of the food intake of infants and small children and assessment of the impact of food supplementation programmes; tracking of household patterns of growth attainment and survival; and tracking of patterns of health service utilization and their effect on child survival. In-depth interviews and other qualitative research techniques should be used to identify the factors which contribute to particular behaviours and practices. Although this is ambitious and costly, it is apparent that lesser research designs do not provide precise answers about the associations and mechanisms which determine child survival.

The third and central objective of this study was to compare patterns and correlates of mortality and growth attainment across the three countries, with a view to identifying those characteristics which point to a greater risk of mortality among children with poor growth attainment. The preceding analysis has contributed insights into the patterns of growth attainment among Burundais, Ugandan and Zimbabwean children, and has identified similarities and differences between the correlates of mortality and growth attainment.

Chapter Five found similar distributions of both raw and age-standardized heights and weights in all three countries. Moreover, although the mean Z-scores of both males and females in all three countries are close to the reference values at ages 0-3 months, all three show a consistent deterioration with age, which is particularly marked between the ages of about six and 18 months.

This suggests that the WHO/NCHS/CDC reference population is a reasonable representation of growth potential for these countries, and that the consistent shortfall is due to other factors. The main causes appear to be inadequate food supplementation after age six months, inadequate weaning foods, and frequent infections because of poor hygiene. The nutrition / infection synergy is thus a major factor preventing optimum growth of these African children. This has important implications for the development of health policy. First, it seems clear that the development of local reference standards for the measurement of child growth attainment is unnecessary.

Second, more effort is needed to improve child nutrition and to reduce disease transmission in all three countries.

The most striking and most important finding of this study is that in all three data sets the significant correlates of mortality are mainly demographic factors, while the significant correlates of poor growth attainment are mainly environmental and socio-economic factors. The analysis in Chapter Four shows that one of the strongest demographic correlates of mortality is *birth interval. Birth interval less than 24 months*, and the related variable, *three or more births in the preceding five years*, are associated with dramatically reduce survival probabilities in all three countries, even after allowance is made for those short birth intervals and additional births which occur because of the death of a previous child. Other demographic variables which increase the risk of mortality are *multiple birth* and *dead sibling*. The results were similar when the effects of variables with lower levels of significance were controlled with multi-variate techniques. In each country the odds of dying reduce as the child's age increases, while in Burundi and Zimbabwe a greater *number of births in the preceding five years* and *dead sibling* or *multiple birth* significantly increase them. In Uganda the odds of dying are significantly higher for male children and where the husband is illiterate, with *husband illiterate* being the only significant socio-economic variable in any of the three models.

In contrast, the factors shown in Chapter Six to be significantly associated with poor growth attainment are predominantly environmental or socio-economic. Aside from *child's age,* the only demographic variable appearing consistently in the growth attainment models is *preceding birth interval.* Children with a short preceding birth interval generally have a greater risk of being stunted or underweight than children with preceding birth intervals of two years or more. This appears to be a direct result of sibling competition. It can thus be argued that, in this instance, birth interval is acting more as a determinant of the child's environment than as a demographic variable.

Region of residence appears in both the height and weight models for Burundi and Uganda, and the related variables, *strata* and *type of toilet facility*, appear in the Zimbabwe models. A significant negative relationship with *mother's* and *husband's education* or *literacy* is apparent in all three countries. High status occupations are associated with lower odds of poor growth attainment in Burundi, but the pattern for *occupation* is inconsistent in Zimbabwe.

As pointed out, this contrast may be partly due to sample bias in the data, since the majority of child deaths occurred in infancy, while poor growth attainment tends not to manifest until after age one year. It was not feasible to compare the correlates of mortality and poor growth attainment for children aged 12 months or more because the number of deaths at ages 12-60 months was too small to yield meaningful results in a multi-variate model. However, the relative absence of clustering of mortality and poor growth attainment within families provides more evidence that there is a real difference in the correlates and causes.

Another important constraint on the foregoing analysis is the absense of information on the growth attainment of dead children. Hence growth attainment could not be included in the multi-variate models for mortality. Moreover, there are insufficient cases of wasting to support detailed analysis of the correlates of this condition. As observed in Chapter Six, it is likely that growth faltering preceded mortality in most cases, that most of the children who died were wasted immediately before death, and that many would have been stunted and underweight.

However, even if it is assumed that this were true for all children, it is not a simple task to use growth attainment at an earlier date to predict mortality, since it can change quickly. A valid comparison can be made only of children whose measurements were taken the same number of weeks before death. A child's anthropometric status is almost certain to be significantly better six or even three months before death than at the time of death. Hence the strength of the association would be likely to vary, depending on the time interval selected between measurement and death.

However, the demographic, environmental and socio-economic variables associated with mortality and poor growth attainment are relatively stable for each child. Although it is not possible to draw a firm conclusion without time-series data, this study has shown a direct association on one hand between birth interval, several environmental and socio-economic characteristics and poor growth attainment, and on the other hand between several demographic characteristics and mortality. To complete the picture requires further analysis of the direct association of poor growth attainment with mortality. This should include a comparison of the correlates of mortality and growth attainment for children aged 12 months or more, using data sets which include substantially more deaths at older ages than in the DHS data available for the present study. This would contribute valuable information for the development of strategies to distinguish those children with poor growth attainment who have a higher risk of mortality.

Although various studies have related cross-sectional growth attainment to subsequent mortality (for example; Kielmann and McCord, 1978; Chen, Chowdhury and Huffman, 1980; Heywood, 1982; Bhuiya, Wojtyniak and Karim, 1989) they have generally lacked the data to compare the predictive value of growth attainment and demographic factors at different stages in a child's life. This would require anthropometric measurements for children who subsequently die, at specific intervals before death, say, nine, six and three months.

It is suggested that growth monitoring cards might be a reasonably accessible source of suitable data for further research in this area, since they include some demographic data, while additional demographic data possibly could be obtained from child-health clinics. A detailed analysis of a large sample of growth monitoring cards for both surviving and dead children could be carried out in Zimbabwe, for example. This could help to determine whether the correlates of growth attainment and mortality differ for children who die after infancy, and if there is a consistent relationship between growth attainment and mortality. Such a study could show whether at, say, nine and six months before death demographic factors were more significant predictors of future mortality than current growth attainment. Research of this nature would have important implications for the early identification of high-risk children and for nutrition and health intervention strategies.

Although some findings of the present analysis cannot be regarded as conclusive because of data limitations, the observed strong association of birth interval with mortality has clear policy implications. It is recommended that all children with preceding and / or succeeding birth intervals of two years or less, all children from families with three or more children under age five years and all children with a dead sibling in the three study countries should be singled out for close monitoring and special attention in times of crisis and food scarcity, regardless of their growth attainment. Currently this is not common practice in either developing or developed countries, with most intervention programmes identifying targets only by their physical characteristics. For example, the Zimbabwean Child Supplementary Feeding Programme relies entirely on the measurement of mid-upper arm circumference

(MUAC) to screen children (Zimbabwe, Ministry of Health, 1992: 2-6). In the USA Jennings et al. (1991: 10) found that only one of 17 food supplementation programmes included socio-economic characteristics when identifying targets. None included any demographic characteristics other than a maximum age for candidates of three or five years.

Appropriate special interventions for children who are considered to have an elevated mortality risk could include evaluating their diets and supplying additional vitamin supplements if diets are found wanting, whether or not these children fall below the cut-off point for inclusion in a food supplementation programme. Adequate intakes of vitamins would enhance the ability of children who have high-risk demographic characteristics to withstand and recover from episodes of infection.

The preceding analysis also focuses attention on the need to evaluate the significance of stunting. The difference in the correlates of mortality and poor growth attainment lends support to the view of Royer and Waterlow (1985: 64) and Mora (1985: 270) that stunting could be a useful and normal adaptation to food scarcity which improves a child's chances of survival. However, as others have pointed out, stunting brings an opportunity cost to an individual and cannot be regarded as a desirable outcome, even if it is a useful adaptation (Gopalan, 1988; Martorell, 1989). While this is true, it would seem from the literature that the real opportunity costs of stunting are not known. Although studies such as FAO/WHO (1992: 25), Correa (1975: 30) and Spurr et al. (1983) have found permanent physical and mental impairment as a result of sustained malnutrition, there is an absence of precise information. For example, although it seems obvious that severe stunting is damaging, it is not known what level of stunting produces permanent impairment, or whether moderate stunting itself is important in the absence of nutrient deficiencies. As a consequence, food supplementation programmes such as the Zimbabwe Child Supplementary Feeding Programme are undertaken without accurate knowledge of whether it is important to prevent stunting, whether the amount of food provided by the programme is sufficient for prevention, or how children are affected if their food intake declines when supplementation is discontinued (J.Tagwireyi, personal communication).

In particular, there is a pressing need for clinically-based prospective studies of the implications of mild stunting. That is, studies of the levels of stunting and underweight which are close to the mean for weanlings in the three countries in this study (see

Figures 5.10 to 5.15). Such studies should seek to identify the level at which poor growth attainment has significant consequences for health.

To argue that any degree of stunting is unacceptable is to close one's eyes to the realities of food supply in Africa and the practicalities of managing food supplementation programmes in times of crisis. Information is therefore needed on the implications of mild, moderate and severe stunting so that countries can make realistic policy for food programmes. Such information would be of great value, even for extreme crisis situations when food supplementation programmes can hope only to reduce mortality. To put it simply, it should not be necessary to undertake food supplementation programmes without knowing what results can be expected in terms of the future health of the population. Governments and NGOs should be able to formulate a programme objective of either minimising deaths or maintaining a certain level of growth attainment, depending on available funding. They should then have access to information which allows the amount of food supplementation to be determined accordingly.

The narrow age range of measured children, especially in Burundi, prevented this study from reaching firm conclusions about the patterns of growth attainment within families. The bi-variate analysis indicated that in all three countries almost all occurrences of both stunting and underweight in a single family involved the same child. Substantial percentages of mothers with more than one stunted child were found only in Uganda, where the sample was larger and fertility was higher. Even in Uganda, less than 5 per cent of mothers had more than one child who was underweight. Again this points to the need for long-term prospective studies. Tracking the growth attainment of entire families as they pass through the weanling period would provide the necessary data to determine whether there is significant clustering of poor growth attainment in families.

The present study proposes an original approach to the analysis of sibling growth attainment. Despite the constraints of small numbers of cases, the analysis shows that, generally, differences between siblings tend to be relatively small once the normal age pattern of growth attainment in each country is controlled. The analysis of the few cases in which there was a difference of more than 1 SD between siblings raises some interesting issues which should be resolved by further research with larger samples. It is important to establish factors associated with significant disadvantage to either older or younger siblings, since this could shed light on the mechanisms which contribute to the higher probability of dying of those children who have a dead sibling.

If sibling patterns are by nature erratic, the policy implications for identifying high risk children are different than if they are consistent. That is, evidence of a consistent pattern could signify that the siblings of children selected for intervention also should be targeted. If it is found that there is an age at which sibling differences are likely to appear, this too could help target intervention strategies.

The scarcity of existing studies which address these issues must be attributed to the cost and logistic problems of collecting data on large samples of pairs of siblings. DHS data sets are among only a few to have collected large cross-sectional samples of heights and weights, and, as shown here, they are still insufficient to support firm conclusions. Of more use would be large longitudinal data sets which could support direct comparisons of siblings over time.

As noted above, there is evidence of significant clustering of mortality within families in all three countries, but it is notable that clustering was greatest in Zimbabwe, where overall infant and child mortality rates are lowest. This seems to reflect the existence of a small group of disadvantaged mothers in the Zimbabwe survey who lacked education, had no knowledge of ORT and lived in underprivileged environments. It is possible that, had data on immunization of dead children been available, the Zimbabwean mothers who had experienced clustering of deaths would have proved to be those with the lowest immunization rates among their children.

This pattern of most clustering in the country with lowest overall mortality rates has clear implications for health policy. It suggests that in Zimbabwe the benefits of better education and health care have reached widely to the majority of surveyed mothers, and it is now time to focus on the few who have not been reached. On the other hand, in Burundi and Uganda there is still a demonstrated need for broad-brush health campaigns to reduce infant and child mortality.

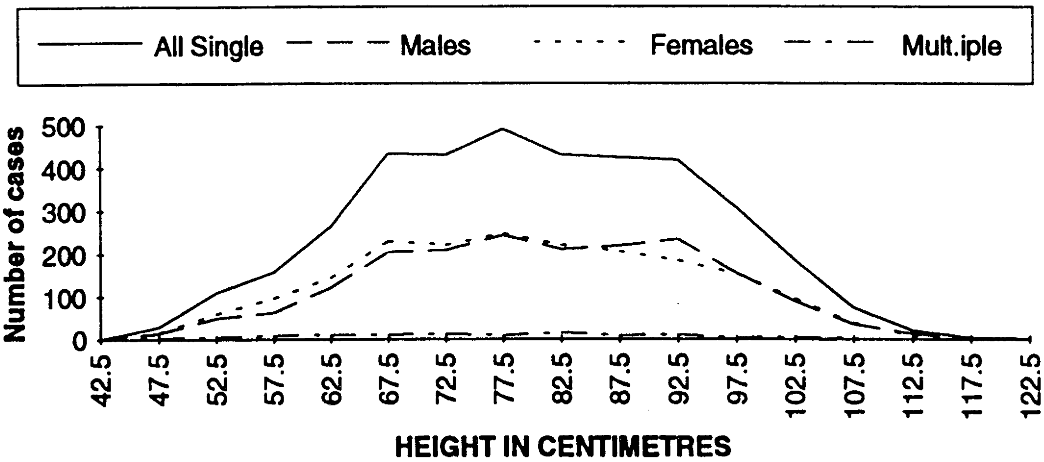
Further evidence of the effectiveness of education and health care in Zimbabwe is the greater percentage of recent deaths occurring in the first month of life and the smaller percentage dying at weaning age compared with Burundi and Uganda. Deaths in the first month of life tend to be predominantly due to biological factors, which are less easily prevented by modern health care. Hence their relative increase in importance suggests that the Zimbabwean health programme is more effective in improving child survival at older ages.

It must be observed that there are still many gaps in knowledge about the relationship of nutrition and growth. Until these gaps are filled there can be no accurate quantification of the mortality risks of children with poor growth attainment. Among the research priorities listed by Waterlow et al. (1991) are the relationship of energy expenditure and metabolism; daily and seasonal variability of weight gain and its effect on protein requirements; the reversibility of stunting; the relationship of growth and food intake; the effects of physical activity on growth and metabolism; and the development of field methods for assessing the severity and intensity of infection. Research on most of these topics requires prospective studies with clinical monitoring of subjects. However, as more is learned about nutrition and growth, it is important that the design of cross-sectional surveys is adapted to collect more appropriate information and to ensure their continuing utility in the study of growth attainment at the population level.

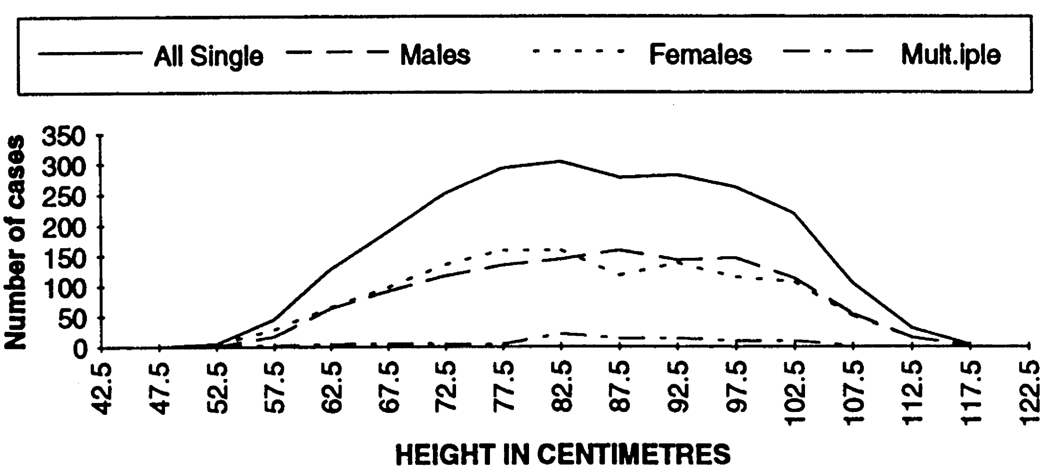
The present study has contributed an appropriate theoretical framework for the study of child growth attainment. It has evaluated the strengths and limitations of cross-sectional data sets and concluded that, despite some limitations, they have considerable utility in the study of mortality and growth attainment. The analysis of cross-sectional data has contributed to the understanding of patterns of growth attainment in the three study countries, and pointed to important differences between the correlates of mortality and growth attainment. This provides an improved basis for further research on the association of mortality and poor growth attainment, and for the development of new and better strategies to advance child health and survival in developing countries.

ANNEXED FIGURES

Annex Figure 1A: DISTRIBUTION OF RAW HEIGHTS OF MEASURED CHILDREN AGED 0 - 60 MONTHS : UGANDA

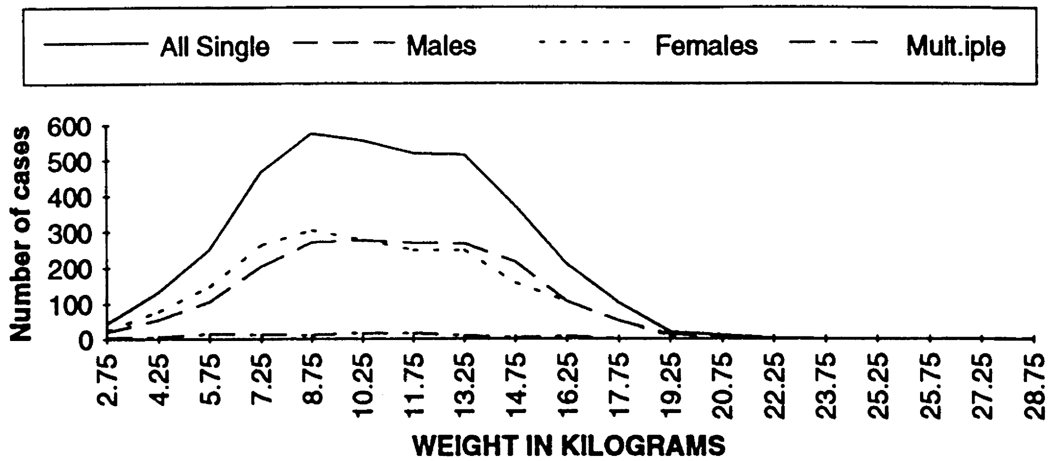


Annex Figure 1.B: DISTRIBUTION OF RAW HEIGHTS OF MEASURED CHILDREN AGED 3 - 60 MONTHS: ZIMBABWE

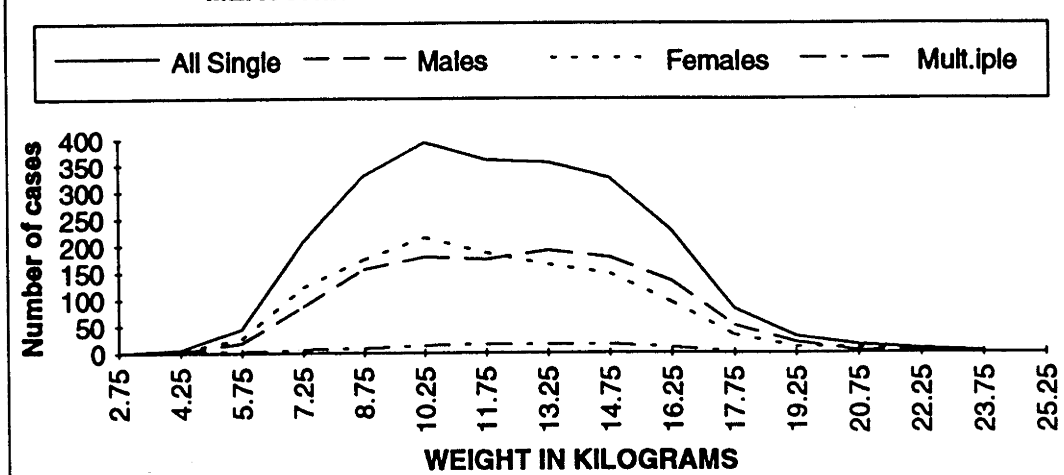


SOURCE: As for Tables 4.5 and 4.6.

Annexe Figure 2A: DISTRIBUTION OF RAW WEIGHTS OF MEASURED CHILDREN AGED 0 - 60 MONTHS: UGANDA

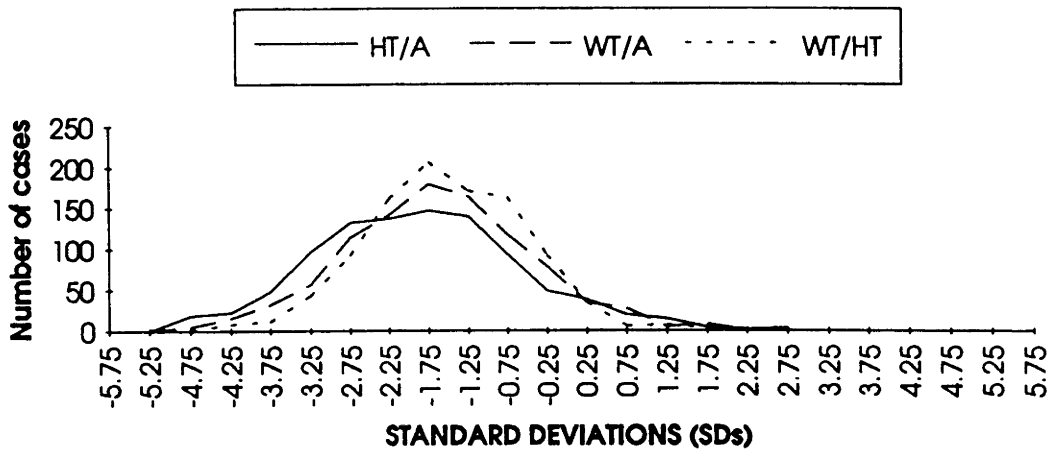


Annex Figure 2B: DISTRIBUTION OF RAW WEIGHTS OF MEASURED CHILDREN AGED 3 - 60 MONTHS: ZIMBABWE

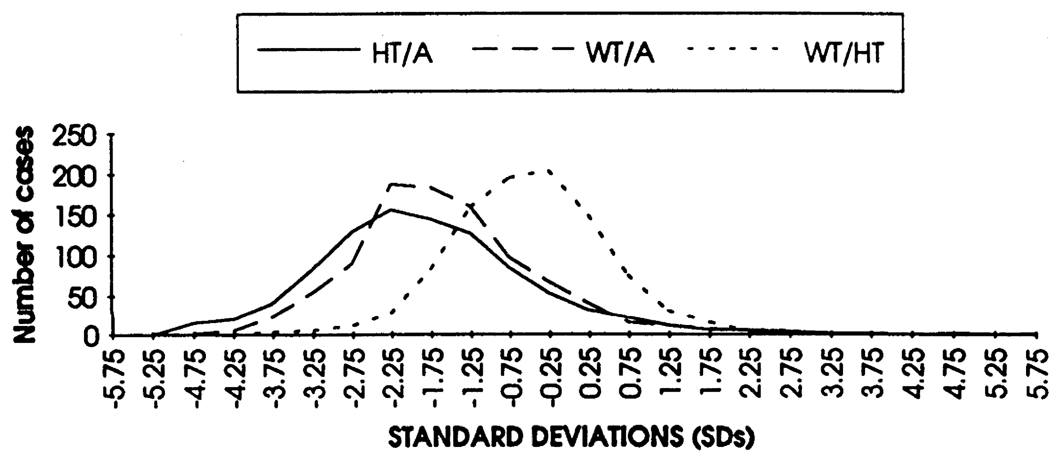


SOURCE: As for Tables 4.5 and 4.6.

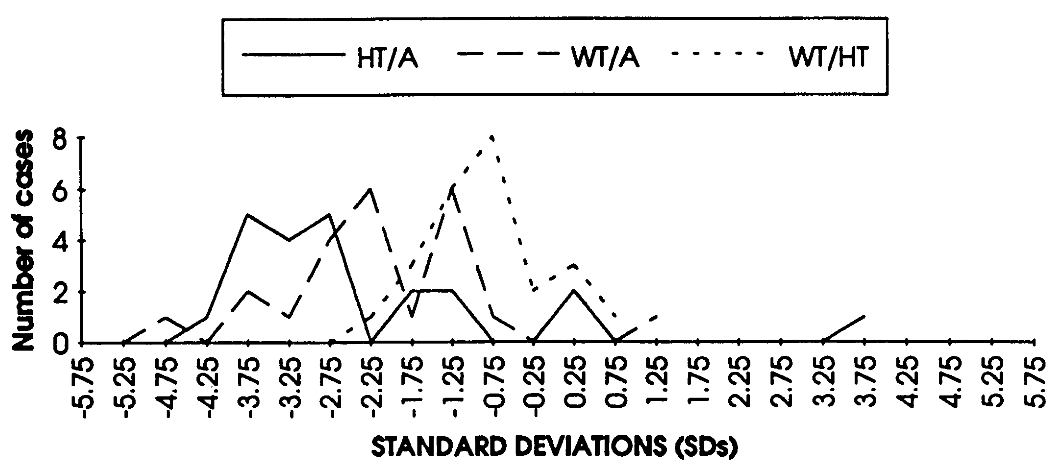
Annex Figure 3.A: Z-SCORES, MEASURED MALES, 3 - 36 MONTHS: BURUNDI



Annex Figure 3B: Z-SCORES, MEASURED FEMALES, AGED 3 - 36 MONTHS: BURUNDI

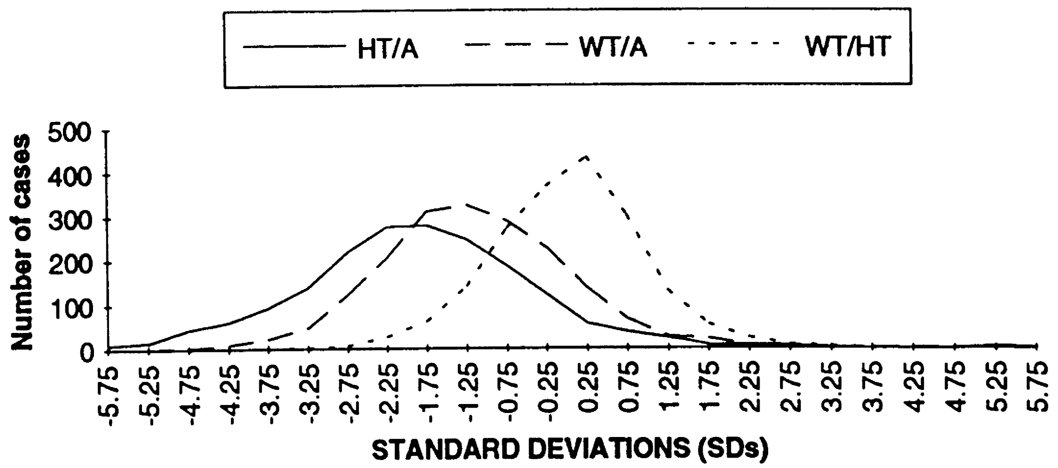


Annex Figure 3C: Z-SCORES, MEASURED MULTIPLE BIRTHS, 3 - 36 MONTHS: BURUNDI

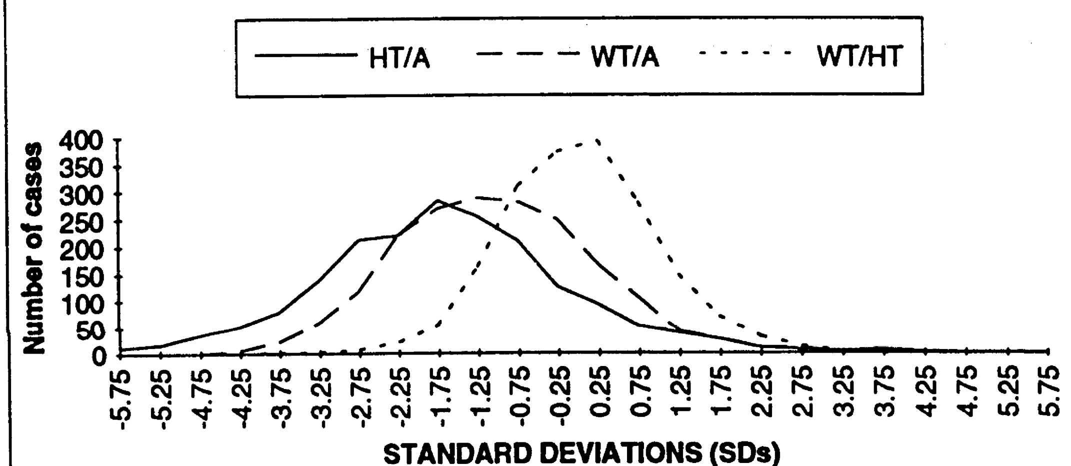


SOURCE: As for Table 4.4.

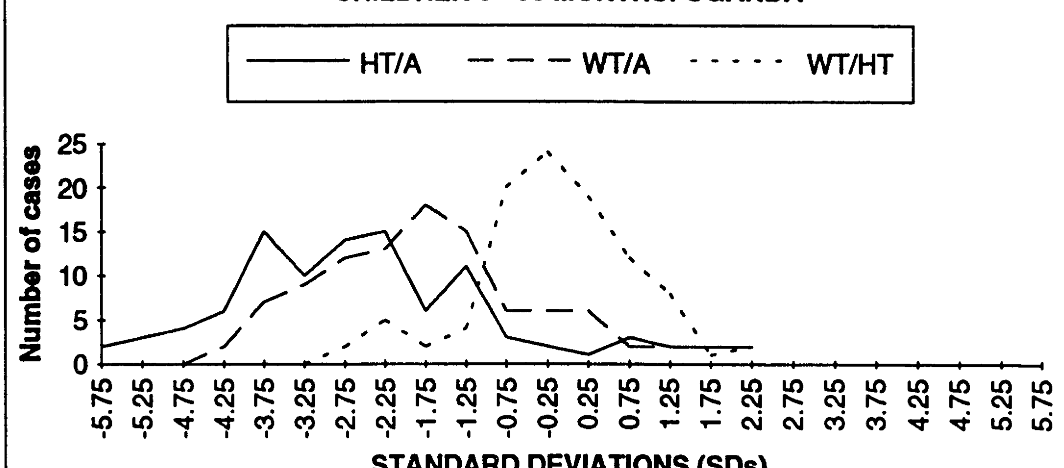
Annex Figure 4A: Z-SCORES, MEASURED MALE CHILDREN 0 - 60 MONTHS: UGANDA



Annex Figure 4B: Z-SCORES, MEASURED FEMALE CHILDREN 0 - 60 MONTHS: UGANDA

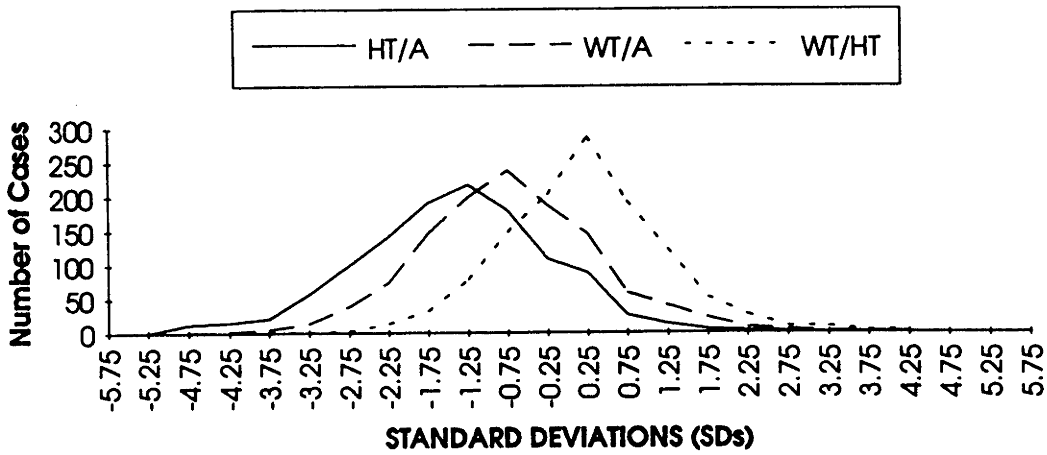


Annex Figure 4C: Z-SCORES, MULTIPLE BIRTH MEASURED CHILDREN 0 - 60 MONTHS: UGANDA

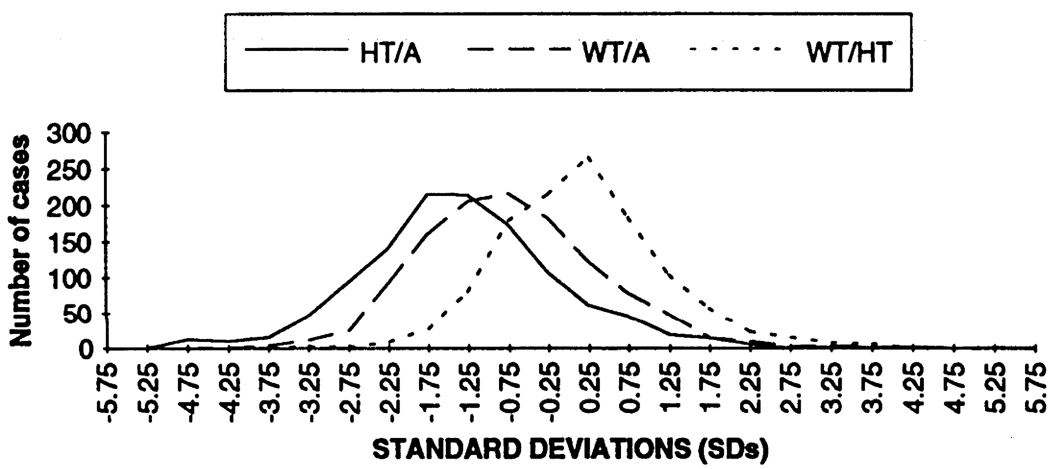


SOURCE: As for Table 4.5.

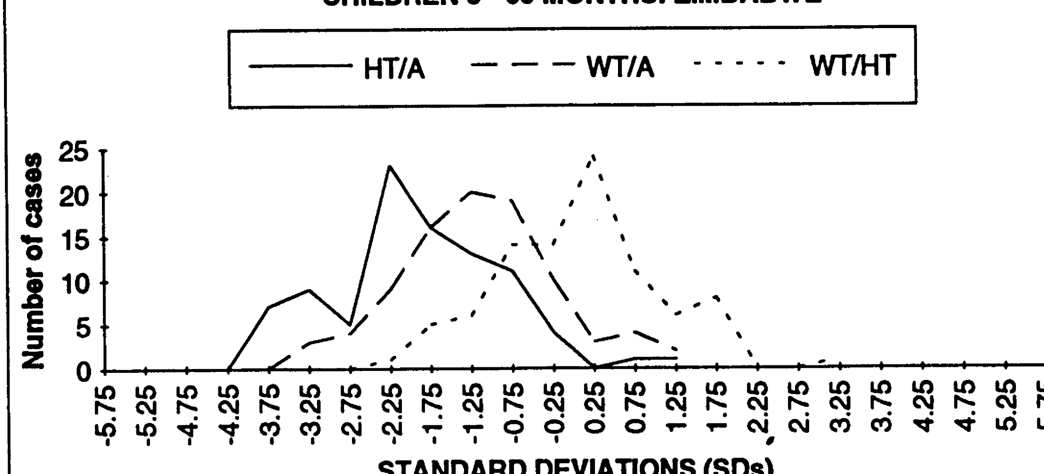
Annex Figure 5A: Z-SCORES, MEASURED MALE CHILDREN AGED 0 - 60 MONTHS: ZIMBABWE



Annex Figure 5B: Z-SCORES, MEASURED FEMALE CHILDREN 0 - 60 MONTHS: ZIMBABWE



Annex Figure 5C: Z-SCORES MULTIPLE BIRTH MEASURED CHILDREN 0 - 60 MONTHS: ZIMBABWE



SOURCE: As for Table 4.6.

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